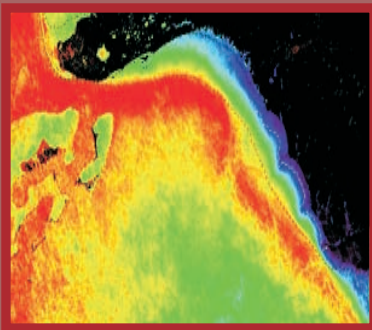
Indonesia and Climate Change: Current Status and Policies



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Preface

This paper is based on an assignment from DFID and the World Bank, in consultation with the State Ministry of Environment in Indonesia, to compile data and information that reflects the most updated state of knowledge of Climate Change in Indonesia.

The document is a synthesis of existing information, does not present new data and is not necessarily based on official Government of Indonesia statistics. It does not serve as an official publication from the State Ministry of Environment, nor does it represent the views of DFID or the World Bank. Rather it is a professional desk review of existing published information, and including two specialist consultation events, commissioned from the consultant, PT. Pelangi Energi Abadi Citra Enviro (PEACE).

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1. EXECUTIVE SUMMARY

Deforestation, peatland degradation, and forest fires have put Indonesia among the top three largest emitters of greenhouse gases in the world. Emissions resulting from deforestation and forest fires are five times those from non-forestry emissions. Emissions from energy and industrial sectors are relatively small, but are growing very rapidly.

At the same time, Indonesia stands to experience significant losses with climate change. Being an archipelago, Indonesia is very vulnerable to the impacts of climate change. Prolonged droughts, increased frequency in extreme weather events, and heavy rainfall leading to big floods, are a few examples of the impacts of climate change. The inundation of some parts of the country, for instance Jakarta Bay, has come to pass; Indonesia's rich biodiversity is also at risk. In turn, this may lead to harmful effects on agriculture, fishery and forestry, resulting in threats to food security and livelihoods.

Indonesia will host the 13th Conference of the Parties to the United Nations Framework Convention on Climate Change, which serves as the Third Meeting of the Parties to the Kyoto Protocol in Bali, December 3-14, 2007. This report has been prepared as an input to the COP/MOP, on the occasion of Sir Nicholas Stern's visit to Indonesia. The report discusses emissions, impacts, and policy constraints faced by Indonesia to cope with climate change.

Emissions

Indonesia is among the top three GHG emitters in the world due to land use change and deforestation. Indonesia has become one of the three largest emitters of greenhouse gases in the world (see Table & Figure 1). This is largely due to the significant release of carbon dioxide from deforestation. Yearly emissions in Indonesia from energy, agriculture and waste all together are around 451 million tons of carbon dioxide equivalent ($MtCO_2e$). Yet land-use change and forestry (LUCF) alone is estimated to release about 2,563 $MtCO_2e$ – mostly from deforestation, as estimated by the IPCC (Houghton 2003, cited in Baumert *et al.* 2005). While data on the emissions from different sources does vary between studies, the overall conclusion is the same. Indonesia is a major emitter of GHGs.

Table 1. GHG emissions summary (MtCO2e)[1]

Emissions sources	United States	China	Indonesia	Brazil	Russia	India
Energy[2]	5,752	3,720	275	303	1,527	1,051
Agriculture[3]	442	1,171	141	598	118	442
Forestry[4]	(403)	(47)	2,563	1,372	54	(40)
Waste[5]	213	174	35	43	46	124
Total	**6,005**	**5,017**	**3,014**	**2,316**	**1,745**	**1,577**

Note: (1) The table excludes EU from the comparison as EU comprises 25 countries. If EU as a block enters the calculation, Indonesia stands 4th, and the ranking are US, EU, China and Indonesia. (2) The data for energy emissions are from 2003. The energy data used IEA's 2005 annual statistics except for Indonesia where PIE 2005 statistics are used. (3) The data for agriculture emissions are from 2005, from US EPA 2006. Biomass combustion is included in the calculation. (4) The data for forestry (LULUCF) emissions are from 2000, from Houghton 2003. (5) The data for waste emissions are from 2005, from US EPA 2006.

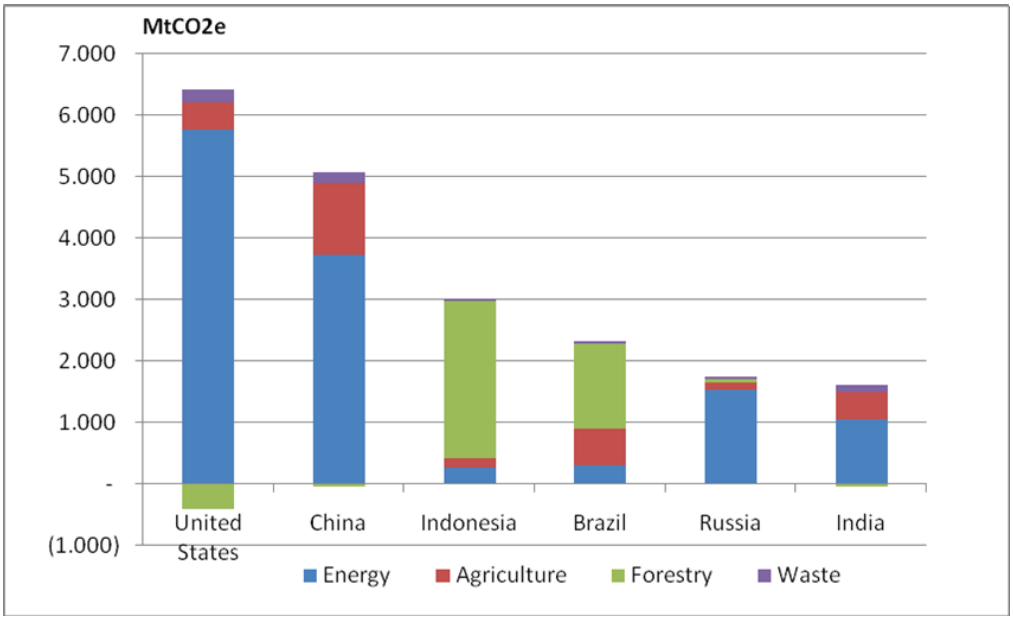

Figure 1. The Comparison of GHG Emission

Indonesia is host to vast forested areas. About 24 billion tons of carbon stock (BtC) are stored in vegetation and soil, and 80 percent of this (about 19 BtC) is stored in the standing forest (State Ministry of Environment, 2003). But out of the 108 million ha of forest area, almost half is in poor and degraded conditions (Departemen Kehutanan RI, 2006). Land use change and deforestation, estimated at 2 million hectares (ha) per year (World Bank 2000) results in the release of a large amount of Indonesia's carbon reservoir. Indeed, the emissions from LULUCF, notably deforestation, account for 85 percent of the yearly emissions of greenhouse gases in Indonesia, and 34 percent of global LULUCF emissions.

Deforestation and land conversion are the largest sources of emissions. The largest carbon dioxide emissions in the forestry sector, about three-quarters (75 percent), come from deforestation and land conversion, followed by forest-related energy consumption (23 percent), and the remainder is from forest-related industrial processes (2 percent). Forest fires are the main contributor of deforestation and land conversion, accounting for 57 percent of total deforestation and land conversion. In the 1997 forest fires alone, it is estimated that between 3,000 and 9,000 $MtCO_2e$ were released to the atmosphere (Page et al. 2002). On average, around 1,400 Mt are released during the annual burning season and 600 Mt are released each year from decomposition of dry peat (Wetlands International n.d.). Global warming will likely cause a vicious cycle by drying up the rainforest and peat swamps, thus increasing the risks of even more intense fires.

Emissions from the energy sector are small but are growing very rapidly. Emissions from non-forestry sectors are small, in absolute and per capita terms, but are growing very rapidly. Current emissions from the energy sector, about 275 $MtCO_2e$, account for 9 percent of the country's total emissions. But these emissions from industry, power generation, and the transport sector are growing very rapidly in the wake of industrialization and economic growth. It is expected that, with current governmental policies that promote the expansion of fossil fuels and the high barriers to clean and renewable sources of energy, the trend is that emissions from energy sector will continue to demonstrate a strong growth, tripling in the next 25 years from about 275 $MtCO_2e$ in 2003 to about 716 $MtCO_2e$ in 2030. Improvement in energy intensity of the economy, about 2 percent between 2000 and 2004, has been offset by strong economic growth as a whole. On a per capita basis, greenhouse gas emissions in Indonesia have grown 150 percent since the 1980s, or 67 percent since 1990 (World Resources Institute 2007).

Emissions from agriculture and waste are small. Emissions from the agriculture and waste sectors are very small and insignificant globally, coming mainly from rice production. The sector is the main contribution of methane (CH_4) and nitrous oxide (N_2O) emissions. Seventy percent (70 percent) of the emissions from the agriculture sector are generated by rice cultivation. Albeit small, greenhouse gas emissions from the Indonesian waste sector in 2000 ranged from 32 – 60 $MtCO_2e$. This ranks Indonesia as the sixth largest emitter in the waste sector (USEPA 2006).

Impacts

Indonesia will experience modest temperature increase. Annual mean temperature in Indonesia has been observed as increasing by around 0.3 degrees Celsius (^oC) since 1990 and has occurred in all seasons of the year, relatively consistent if not slightly lower than the expectation of the warming trend due to climate change. The 1990s was the warmest decade and a 1998 increase of almost 1^oC (above the 1961 –

1990 average) made it the country's warmest year in the century (Hulme, et al., 1999).

Indonesia will experience more intense rainfall. Climate change is predicted to result in 2 percent to 3 percent more rainfall per year in Indonesia (Ratag 2001 in Susandi 2007). As Figure 2 shows, the entire country will experience more rainfall, with the largest change being in the Moluccas. The increased rainfall is expected to continue and, due to climate change, result in a shorter rainy season (fewer number of rainy days in a year), with significant increase in the risk of flooding.

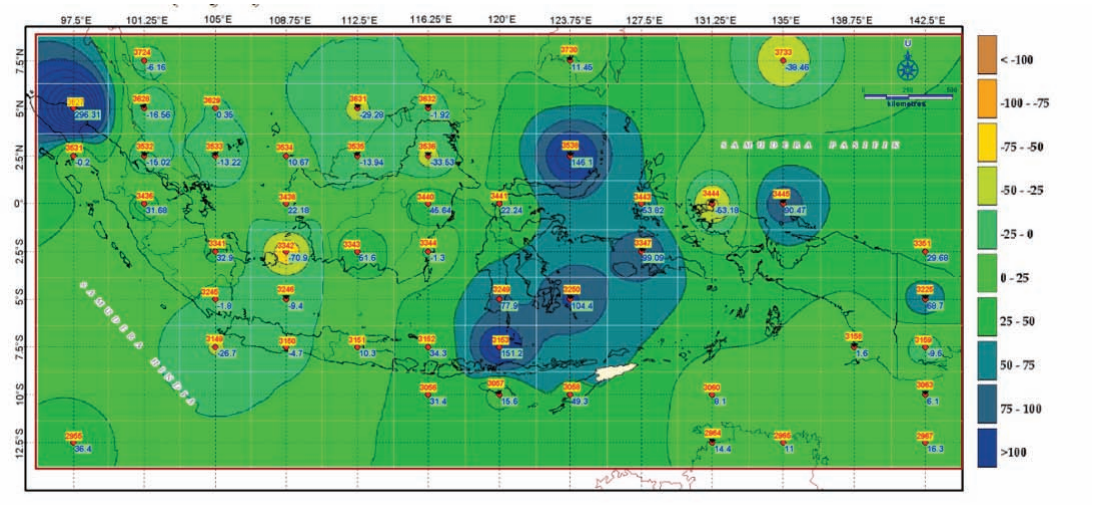

Figure 2. The Average Change of Precipitation Pattern 1900-2000 September-October-November (in mm/100 years) (Ratag, 2007)

Food security in Indonesia will be threatened by climate change. Perhaps the largest concern for Indonesia with regards to the impacts of climate change is the risk of decreased food security. Climate change will alter precipitation, evaporation, run-off water and soil moisture; hence will have effects on agriculture and thus food security. The droughts caused by the 1997 El Nino event affected 426,000 hectares of rice. Important income-generating non-food crops such as coffee, cocoa and rubber were also affected (FAO, 1996). Projected changes in crop yields in Asia could vary between -22 percent to +28 percent by the end of the century in the event of a doubling of atmospheric carbon dioxide concentrations (Reilly, 1996). A model simulating the impacts of climate change on crops (Goddard Institute of Space Studies, UK Meteorological Office) shows a decrease of crop harvest in West and East Java. Climate change will likely reduce soil fertility by 2 percent to 8 percent, resulting in projected decreases of rice yield by 4 percent per year, soybean by 10 percent, and maize by 50 percent (Amin, 2004 and Parry and Nih, 1992)

Sea level rise will inundate productive coastal zones. Climate change will also increase the average sea level due to increased volume of the sea water and the melting of polar ice caps. The mean sea level in the Jakarta Bay will increase as high as 0.57 centimeters (cm) per year. The average depth of inundated area varies between 0.28 and 4.17 in 2050 (Meliana 2005). This coupled with the land surface decline as high as 0.8 cm per year, as observed in the Jakarta Bay, can have a tremendous impact on urban productivity and infrastructure (Priambodo 2005). Also, in rural districts such as Krawang and Subang, a 95 percent reduction in local rice supply (down 300,000 tons) is estimated as a result of inundation of the coastal zone. In the same districts, maize output would be reduced by 10,000 tons, about half of this due to inundation.

Sea level rise will reduce farming and coastal livelihoods. Sea-level rise would also be likely to affect fish and prawn production. In the Krawang and Subang districts, the loss is estimated at over 7,000 tons and 4,000 tons, respectively (valued at over US$ 0.5 million). In the lower Citarum Basin, sea-level rise could result in the inundation of about 26,000 ha of ponds and 10,000 ha of crop land. This could result in the loss of 15,000 tons of fish, shrimp and prawns output, and about 940,000 tons of rice production.

The overall effect would be to reduce potential average income. The estimated reduction of yield would cost the rice farmer US$ 10 to US$ 17 annually, the soybean farmer US$ 22 to US $72 and the maize (corn) farmer US$ 25 to US $130 annually. It is estimated that the decrease in yield would cause, in the Subang District alone, about 43,000 farm laborers to lose their jobs. In addition, more than 81,000 farmers would have to look for other sources of income due to the inundation of their rice fields or prawn and fish farms due to sea-level rise (Parry & Nih, 1992).

The warming of ocean water will affect marine biodiversity. Climate change will subject Indonesia's ocean water to an increase in temperature of 0.2 to 2.5 ^{o}C. The 50,000 km^2 of coral reefs in Indonesia, about 18 percent of the world's total, are already in dire straits. The El Nino event in 1997 – 1998 alone was estimated to have caused coral bleaching to 16 percent of the world's coral reef. In a 2000 survey, only 6 percent of Indonesia's coral reefs are in excellent condition, 24 percent in good condition, and the remaining 70 percent are in fair to poor condition (John Hopkins University and Terangi, 2003). A survey in the Bali Barat National Park found that a majority of coral reefs were in poor condition. More than half of the degradation was due to coral bleaching. This puts the Bali Barat National Park as a catastrophically-affected site (Wilkinson, 2000 in Setiasih, 2006). In Pari island, in the Thousand Islands National Park, 50 – 60 percent of the coral reefs were found bleached in 1997 (Irdez 1998 in Setiasih, 2006).

Climate change will intensify water- and vector- borne diseases. In the late 1990s, El Nino and La Nina were associated with outbreaks of malaria, dengue and plague.

Malaria has spread to high elevations where it was detected for the first time as high as 2103 m in the highlands of Irian Jaya in 1997 (Epstein, et al., 1998). In 2004, it appeared that a more virulent strain of the potentially deadly dengue fever virus may have emerged. Dengue fever has been spreading faster and killing more victims than in past years.

The links between climate change and these diseases and health problems is poorly researched. The IPCC's Fourth Assessment Report (2007) stated that there is too little data to reliably confirm perceptions of an increase in extreme weather events, which may be due to increased reporting. However, perhaps as a forewarning of what is to come, the rise in the number of dengue fever cases during the rainy seasons in Indonesia, particularly in Java, could have been partially caused by warmer climates. Research has confirmed that warmer temperature has led to mutation of the dengue virus, making cases more difficult to handle, thus leading to an increase in fatalities

Impacts will be uneven across the country, but result in significant economic damage and loss of livelihoods. For example, the economic impacts of forest fires are estimated to cost an annual US$ 9 billion from droughts and fires (Applegate, May 2006) and US$ 4 billion from haze related costs (International Development Research Center, 2003).

There is no proven evidence yet that intense and more frequent El Nino and La Nina events are caused by or are causing climate change. But these events can be a good proxy for looking at the damage that could occur due to climate change. The rare events could become the norm as the world will get permanently warmer.

Policy and capacity constraints

Indonesia signed the Kyoto Protocol in 1998 and ratified it in 2004 through Law No. 17/2004. Since then, a lot has happened, notably in the field of the clean development mechanism (CDM), although less so in the other fields.

Forestry policies and legislation are good, but implementation and enforcement are weak. There are many good policies and legislations that favor sustainable forest management in Indonesia. Unfortunately, the capacity of the government to implement and enforce laws is weak. For example, through Presidential Instruction No. 4/2005, Indonesia codifies and reinforces the commitment to fight forest crime. The decree directs eighteen agencies to cooperate in the control of illegal logging and the prosecution of forest crimes, including the Coordinating Ministry of Political and Security Affairs, the Ministry of Forestry, the National Police, and financial sector regulators. An order of the Ministry of Home Affairs has called for cooperation at the district government level and has prohibited further grants of logging concessions at that level. Officials from Police and Prosecutors Office have

been stationed at the Ministry of Forestry, but there is still a need for more detailed plans, budgets, information sharing arrangements and standard protocols (World Bank, 2006).

The policy to expand biofuel production is still risky and problematic. Indonesia is progressing towards expanding biofuel production, both for domestic use in order to reduce oil consumption, and for export due to meet strong demand, especially in Europe. Bioethanol is currently produced using mainly sugar and cassava as feedstocks, whereas biodiesel is developed using crude-palm oil (CPO), stearin (the non-edible byproducts of CPO), Jatropha curcas, and others.

In 2009, biodiesel from oil palm in Indonesia is projected to reach 700 million liters, or 2 percent of diesel consumption, requiring about 200,000 ha of oil palm plantations. Demand for biodiesel is expected to increase in 2025, when it reaches 4,700 million liters, or 5 percent of total diesel consumption. This will need 1.4 million hectares of oil palm plantations – about 2.5 times the area of the island of Bali. Jatropha curcas can grow in degraded lands and promises a good potential to reforest the degraded areas, while at the same time providing livelihoods to the poor living near degraded areas and reducing the use of petro-diesel.

However, the risks of deforestation – and to some extent land use conflicts with biofuels – have not been thoroughly assessed. Historically, oil-palm production in Indonesia has been a major driver of deforestation.

The policy to rapidly expand the use of coal will increase emissions further. Indonesia greenhouse gas emissions from coal burning by the year 2025 will be 20 times higher than in 2005 or 1.3 times higher than all energy sector emissions for the same year (Hutapea, 2007). The decision to rapidly expand coal-fired power generation (by 10,000 MW in Java alone) may increase these emissions even further.

Renewable energy sources are underdeveloped, with barriers but few incentives. At the same time, there are barriers but few incentives in Indonesia for the development of renewable energy. Development of renewable energy has slowed if not halted. While energy policies may call for development of renewable sources, supporting instruments, such as fiscal and financial incentives, have not been fully developed. Table 2 shows the small amount of renewable energy actually utilized compared to the potential. This is very different from China and India, where policies to foster development of renewable sources have been strongly implemented.

Table 2. Indonesian Renewable Energy Potential Compared to Installed Capacity (DGEEU, 2006)

Renewable Sources	Potential		Installed Capacity	
Hydro	75,67	GW	4,200	MW
Geothermal	27	GW	807	MW
Mini/micro hydro	500	GW	84	MW
Biomass	49,81	GW	445	MW
Solar	4,8	kWh/m²/day	8	MW
Wind	3-6	m/s	0,6	MW

The only improvement may have occurred in energy conservation. Energy pricing policy -- that gradually removed subsidies from electricity and fuel – has helped increase conservation of energy. Energy intensity has also been constantly reduced over time.

Indonesia has not yet been able to take advantage of the opportunities in the Clean Development Mechanism. Indonesia has at least 235 $MtCO_2e$ of emissions reduction potential that can be developed as CDM projects, ranging from reduction of gas flaring in large oil and gas facilities, to development of geothermal and other clean and renewable energy sources, to production of biogas from agriculture and animal waste.

However, at present only 11 projects have received approval from the Designated National CDM Authority (DNA). Of these, eight have been registered by the Executive Board of CDM with a potential to produce 13 $MtCO_2e$. From the registered projects, most are renewable and waste management projects (UNEP RISOE, 2007). Compared with the potential, this is not significant.

Indonesia is not yet adequately preparing for adaptation to future climate events. The importance of adaptation to climate change has already been acknowledged in the country's Mid-Term National Development Plan. Chapter 32 of the Plan mentions that Indonesia shall "improve national capacity in adapting climate change issues into development aspects".
Currently, a draft of the National Strategy on Adaptation has been completed. The draft contains a compilation of research activities, identification of adaptation issues that need to revised and expanded with implementation experience of UNFCCC methodology. At present, the Ministry of Environment is finalizing the strategy in time for the COP13 meeting. Other Ministries have yet to follow through by implementing recommendations, resulting in weak preparedness for adaptation to future climate events.

2. INTRODUCTION

Indonesia had become the 16th largest greenhouse gas (GHG) emitter in the world by 2003, with 347 million tons of carbon dioxide equivalent (MtCO2e) per year, contributing 1.34 percent of the world's total emissions that year (Baumert, et al., 2005). With all other non-carbon dioxide GHGs included, 505 MtCO2e per year in total, Indonesia was already ranked 15th in 2000.[1] But when emissions from land use, land-use change, and forestry (LULUCF) were taken into account, immediately Indonesia's place jumped to become the third largest polluter in the world, generating more than 3,068 MtCO2e per year.[2] Emissions from LULUCF accounted for 83 percent of the total emissions of the country.

The impacts are dire. Prolonged droughts, increased frequency of extreme weather events, heavy rainfall leading to big floods, are only a few examples of what climate change may bring. An archipelagic country, Indonesia is very vulnerable to sea level rise. Quite large parts of the country, including the Jakarta bay, will be inundated. Indonesia's rich biodiversity is also under threat. In turn, this may lead to harmful effects on agriculture, fishery, and forestry sectors, resulting in increased threat to food security and livelihoods of the population.

Indonesia will host the 13th Conference of the Parties to the United Nations Framework Convention on Climate Change, which serves as the Third Meeting of the Parties to the Kyoto Protocol (COP/MOP) in Bali in December 3 – 14, 2007. A multi-stakeholder group led by the Ministry of Environment is convened to prepare for the conference. A series of events will take place during the lead-up to the COP, including a visit by Sir Nicholas Stern, author of the recent major report on the economics of climate change. Hosting COP/MOP as well as a visit by Stern reveal a special opportunity for Indonesia to address the issue of climate change.

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[1] Six GHG regulated under Annex A of the Kyoto Protocol are carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and the three industrial fluorinated gases, namely perfluorocarbon (PFC), hydrofluorocarbon (HFC), and SF6.

[2] This number is different from the consultant's compilation, which is about 3,100 MtCO2e. Data from World Resources Institute's CAIT, accessed in March 2007.

In preparation for the Stern visit as well as to serve as an input to the COP/MOP process, the Department For International Development (DFID) of the Government of the United Kingdom and the World Bank sponsored this background paper on Indonesia and climate change. A brief call for short-term consultancy of 20 days to prepare a summary paper on Indonesia and climate change has been made to key researchers of PT. Pelangi Energi Abadi Citra Enviro. The purpose of the paper is to provide the most up-to-date information on Indonesia and climate change that can serve as a starting point for further discussions on the issue.

The paper is a compilation of available information and data, and does not involve recalculating or remodeling of existing data. Several tools developed by international research organizations are used as a source of information or a base of interpolation along with other available official data from relevant departmental agencies. Unofficial data are utilized where official data are not available. When available, the methodology behind the data used is assessed for scientific credibility. However, there are some cases where detailed explanations were not provided.

In addition, two Roundtable Discussions were organized during the preparation of the paper. The first Roundtable was held on March 2, 2007, to obtain sources of data and information from relevant departmental agencies, non-governmental organizations (NGOs) and research institutions. The participants were from the State Ministry of Environment, the Ministry of Energy and Mineral Resources, the Ministry of Health, the Ministry of Public Infrastructure, the Ministry of Marine and Fisheries, the Bandung Institute of Technology, the Geophysics and Meteorology Agency, the Ministry of Forestry, and NGOs such as Yayasan Pelangi Indonesia, Greenpeace, Conservation International Indonesia, as well as international institutions such as the International Center for Research on Agro-Forestry (ICRAF) and Wetlands International. The second Roundtable Discussion was held in March 15, 2007 where a draft paper was presented and discussed by the same participants prior to the delivery of the paper.

The paper comprises sections starting with sectoral greenhouse gas emissions. It is then followed by a section on current and possible climate change impacts to Indonesia. The third section highlights several key gaps in policies and mechanisms in sectors related to climate change. The last section concludes this paper.

3. GREENHOUSE GAS EMISSIONS

This section discusses Indonesian anthropogenic GHG emissions. The key emitting sectors -- forestry, energy, agriculture and livestock, waste -- are discussed below. The section concludes with a comparison of Indonesian emissions with other countries.

FORESTS AND LAND USE

This section discusses the current condition of Indonesia's forest cover and its changes, the underlying causes of deforestation and its relation to the climate change, estimation of carbon stock and carbon emission, comparison of emission to other countries, and the estimated emission trends from this so-called Land Use, Land-use Change, and Forestry (LULUCF) sector. The sources of carbon stock come from forest cover (including peatland forest), woodland, agroforestry, plantation, fallow land, grassland, shifting cultivation/garden, housing compound and surrounding, and mixed unproductive lands. Emissions from the forestry sector occur as carbon stock is depleted and released to the atmosphere caused by changes in forest and other woody biomass stock, forest and grass land conversion, abandonment of managed land, and forest fires. The data used are mainly from the Ministry of Forestry, the World Resources Institute, the Ministry of Environment, Forest Watch Indonesia, and Wetlands International. Comparisons of carbon emissions from LULUCF among countries are presented using graphics and charts developed using the Climate Analysis Indicator Tools (CAIT) Version 04 of the World Resources Institute.

In terms of data validity, differences in definitions of land use type and measurement methodology became the main cause of data inconsistency between the peatland carbon emissions from the Wetlands International and the land use change and forestry (LUCF) emissions data from the WRI. For forest cover data, the study uses the official data from the Department of Forestry in 2000. The emission projections for 2000, 2012 to 2030 in this study use the carbon stock data from Sathaye et al in 2001; however, there are no other data available to compare the accuracy of the projections.

Current Status

Forests play an important role in the global carbon cycle because they store large quantities of carbon in vegetation and soil, exchange carbon with the atmosphere through photosynthesis and respiration, but they are also can become sources of atmospheric carbon when they are disturbed by human or natural causes (e.g., wildfires, use of poor harvesting procedures, cleared and burned for conversion to non-forest uses, illegal logging), and become atmospheric carbon sinks (i.e., net transfer of CO2 from the atmosphere to the land) during land abandonment and re-growth after disturbance (Brown 2002).

To date, Indonesia houses the third largest tropical forest after Brazil and the Congo Basin. Based on the data from the Forest Planning Agency (2005), the extent area of land cover inside and outside forest area up to 2005 is 187.913 million ha (as presented in Table 3, below). Regrettably, almost 50 percent (74 million ha) of the area is degraded and some areas are in critical condition.

Table 3. Forest Figures in Indonesia[3] (Departemen Kehutanan RI, 2006)

Criteria	Forest Area (in 1.000 Ha)						Total (in 1.000 Ha)
	Permanent Forest				Conversion Production Forest	Other uses	
	Conservation Area	Protected Forest	Limited Production Forest	Production Forest			
A. Forest	14,365	22,101	18,180	20,624	10,693	7,960	93,924
B. Non Forest	4,009	5,622	5,765	12,639	11,057	44,163	83,255
C. Data Deficiency	1,502	2,328	1,712	1,995	981	2,216	10,734
Total	**19,876**	**30,051**	**25,656**	**35,258**	**22,731**	**54,339**	**187,913**

Aside from the current forest covers above; there are also a fact that deforestation rate in Indonesia has been increasing significantly. Forest Watch Indonesia/Global Forest Watch, quoting data from Holmes (2000) presents the loss of lowland and other dominant forest types in the three islands between 1900 and 1997. Indonesia's lowland tropical forests, the richest in timber resources and biodiversity, are most at risk. They have been almost entirely cleared in Sulawesi and are predicted to disappear in Sumatra by 2005 and Kalimantan by 2010 if current trends continue (FWI/GFW, 2002). Figure 3 below show the extent of deforestation in Kalimantan up to 2020.

[3] The table was produced from the interpretation of satellite image landsat 7 ETM.

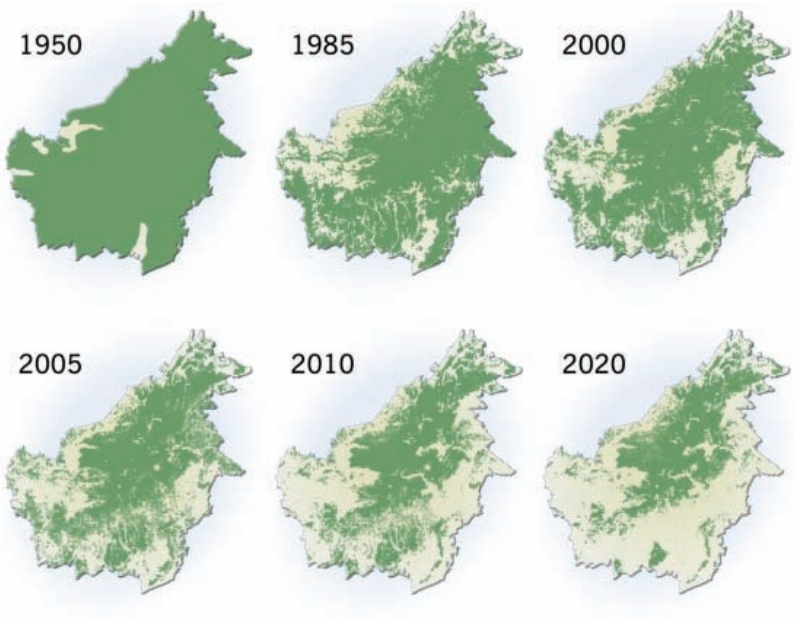


Figure 3. Extent of deforestation in Borneo 1950-2005, and projection towards 2020 (UNEP/GRID-Arendal, 2007)

The recent study regarding data of total carbon stock in Indonesia was conducted by the Ministry of Environment through the National Strategy Study for CDM Forestry in 2003 (see Table 4). Their estimates are based on average carbon storage values for each land use type data in 2000. Up to now, there is no other study available to have this data updated. However from Table 4 below we can have a clear overview about the potential carbon stock in Indonesia which total around 24,704 Mt of carbon. This large amount of carbon stock can potentially be released if the areas are disturbed. The projection of forest cover loss in the table above shows that, from 2000 to 2010, there will be a significant increase of forest cover loss, which will definitely increase the amount of carbon emission released.

Table 4. National carbon stock calculated based on 2000 data (State Ministry of Environment, 2003), sources of information Central Bureau of Statistic (BPS, 2001); MoF (2001); Boer (2001)

No	Land use cover	Area (Ha)	Average C (tC/ha)	Total C (tC)	percent
1	Forest cover[1]	108,571,713	180	19,542,908,340	79.11
2	Woodland/agroforestry	8,905,200	125	1,113,150,000	4.51
3	Agriculture/paddy field	8,106,356	3.5	28,372,246	0.11
4	Plantation	16,543,663	172	2,845,510,036	11.52
5	Fallow land	10,260,492	37	379,638,204	1.53
6	Grassland	2,424,469	10	24,244,690	0.09
7	Shifting cultivation	12,768,711	11	140,455,821	0.56
8	House compound and surroundings	5,131,727	0.5	2,565,836.5	0.01
9	Dyke/ponds	642,905	1	642,905	0.003
10	Mosaic of mixed unproductive lands	17,922,938	35	627,294,570	2.54
	Total land area	191,277,938		24,704,782,676	100

The tremendous increase of carbon emissions from land use change in Indonesia was mainly caused by forest fires and illegal logging. The World Bank (2000) estimates the rate to be more than 2 million ha per year. The World Resource Institute estimates that the largest CO_2 emissions in Indonesian forestry sector, about 74 percent, come from deforestation and land conversion (LUCF). It is followed by forest-related energy consumption (23 percent) and forest-related industrial process (3 percent). Forest fires were the main contributor of deforestation and land conversion, comprising 57 percent. Not only do they contribute to GHG emissions, forest fires also cause serious devastation and degradation to the function of the forest, in addition to haze pollution that negatively affect human health.

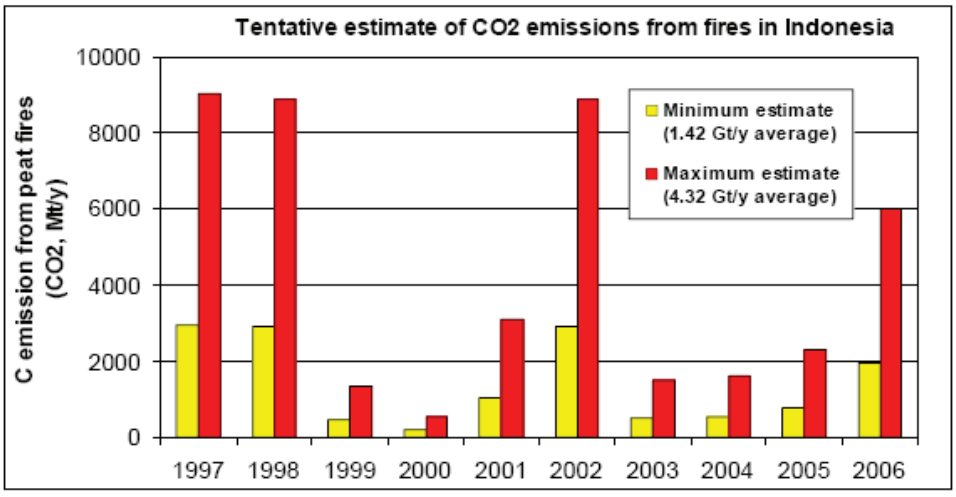


Figure 4. Tentative estimate of annual and average annual carbon emission due to peatland fires, determined on the basis hotspot count (Hooijer, et al., 2006)

The year of 1997, 1998 and 2002 were when the highest rate of forest fires evidenced in the history of Indonesia. Last year, in 2006, forest fires came back in their intense form. This fluctuation of fires cannot be separated from the climatic event ENSO (El Nino Southern Oscillation) which induced long drought season to Indonesia and the surrounding region.

The most recent study on Indonesian forest emission was conducted by the World Resources Institute in 2005. Not surprisingly, Indonesia ranked first among other countries, such as Brazil and Mexico for land use change emission. Quoted from WRI, based on Houghton (2003) total Indonesian LUCF GHG emission were 2,563 Mt CO_2, or 34 percent of world total LUCF GHG emissions (Baumert, et al., 2005). In 2003, Houghton estimates the total Indonesian LUCF GHG emissions of more than 2,500 MtCO_2. It was assumed that forest fires account for 57 percent of the LUCF emission or equals to more than 1,425 MtCO_2.

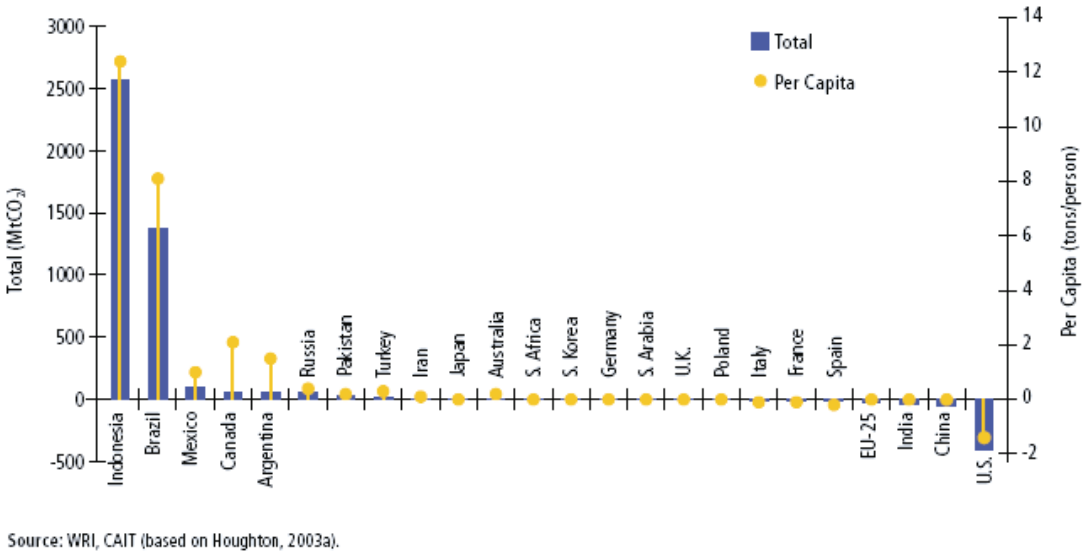


Figure 5. CO2 from Land-Use Change, Total and Per Capita (Baumert, et al., 2005)

Most studies estimate that illegal logging comprises about two thirds of the country's total CO_2 emissions, or between 140 and 250 MtC annually. This is equivalent to a few per cent of global CO2 emissions from fossil fuel use (Persson, et al., 2004). In Mexico, in the recent communication to the UNFCCC, the LULUCF contributes the emission in 2002 a total of 86,877 MtC. These emissions are due to a net amount of 64,484 Mt produced by the combustion and decomposition of biomass associated with the processes of converting forests to other uses, plus 30,344 MtC of emissions derived from mineral soils and agricultural areas, plus emissions of 4,932 MtC from managed forests, subtracting the capture of 12,883 MtC in abandoned lands (Department of Environment, Natural Resources and Fisheries-Mexico, 2006)

In global terms, during the 1990s, The IPCC estimates that global LUCF emissions averaged 1.6 gigatons (GtC) per year ±0.8 GtC. This figure amounts to 20 percent of global CO_2 emissions. Taking uncertainties into account, CO_2 from LUCF may be as little as 0.8 GtC (12 percent of world emissions) or as high as 2.4 GtC (28 percent), a difference of a factor of three. Estimates used are based on Houghton and Hackler (2002) and Houghton (2003), amount to 2.2 GtC per year (26 percent of CO_2 in the 1990s), which is in the upper range of IPCC estimates (Baumert, et al., 2005).

While deforestation alone has contributed significantly to the national GHG emissions, fires from peatland make it even worse. Fires from peatland have become the largest contributor to haze, which is also a major source of carbon emissions. In the 1997/1998, peatland has contributed 60 percent to 90 percent of emissions

release from the forest fires. It is also estimated that the fires released 7 percent of the total global greenhouse gases emission that year and affected the health of 75 million people (BAPPENAS-ADB, 1999).

Many forest areas in Indonesia are located in peat or organic soils that contain large amounts of carbon. Undisturbed in its anaerobic form, peatlands are sinks for CO_2 and sources of CH_4. Drainage of these soils to improve forest productivity virtually stops CH_4 emissions, but initiates rapid CO2 emissions by aerobic decomposition. Draining peat soils for forest establishment can produce a carbon loss from these soils that exceeds that stored in the forest if 20-30 cm of peat decompose as a result of the drainage (Brown 2002).

Research from Wetlands International shows the enormous impact of peatland degradation on climate change. Annually, in Indonesia 2000 million tons of CO_2 are released from forests; 600 million tons are caused by decomposition of dry peat (a process that will continue until all peat has disappeared) and 1,400 million tons through the annual fires.

A study of CO_2 emissions due to peat fires in Indonesia in 1997 by Page et al, 2002 puts the figure between 810 and 2,470 million tons of carbon loss (i.e. 3,000 to 9,000 Mt CO2) in that single event. This number is supported, among others, by the fact that 1997 has had the largest annual jump in global atmospheric CO_2 on record (Page, et al. 2002).

Emissions Projection

A study conducted by Sathaye et al in 2001 listed several options in mitigating carbon emission from Indonesian forest. Mitigation options such as forest plantation, afforestation, reforestation, enhanced natural regeneration, reduced impact logging, bioelectricity to forest protection are modeled into Indonesian data.

This model produced carbon stock projection over thirty years for Indonesian forest. In 2012, the study modeled that without any mitigation option, the carbon stock in Indonesian forest in 2012 shows 6 percent reduction of those in 2000. The carbon lost in 2012 from 2000 equals to 950 Mt C. There are two possibilities, (1) the forest area decreases; or (2) the forest itself releases emissions trough, i.e. forest fire and logging activities (Sathaye, et al., 2001). The situation slightly improved in 2030 as the carbon stock reduction is 2 percent from those in 2012 or 7.6 percent from those in 2000. The carbon lost in 2030 from situation in 2012 equals to 360 Mt C.

Once the mitigation options are imposed on the baseline scenarios, there is significant increase of carbon stock from 2000 to 2030. In 2012, there is incremental carbon stock amounting 728 Mt C. The study projects more optimistic scenario in

terms of mitigation options in 2030, as the carbon stock increases by 2,540 Mt C (see Table 5 and Figure 6. Mitigation model scenario in Indonesia, 2000 – 2030 (Sathaye, et al., 2001).

Table 5. Carbon Stock in mitigation and baseline scenarios (in Mt C). Source: Sathaye, et al., (2001)

Indonesia	2000	2012	2030
Baseline	17,450	16,500	16,140
Mitigation	17,450	17,228	18,650
Increment	0	728	2,540

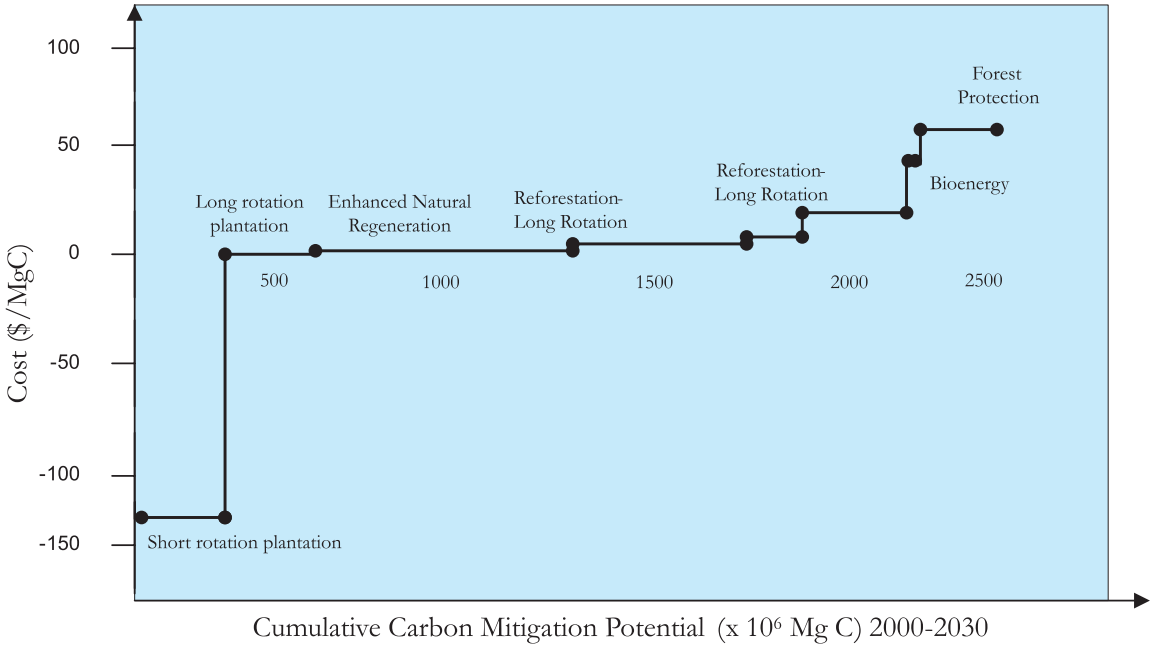


Figure 6. Mitigation model scenario in Indonesia, 2000 – 2030 (Sathaye, et al., 2001)

ENERGY SECTOR EMISSIONS

Emissions from the energy sector are mainly from fossil fuel burning. The data used are mostly from The Information Center on Energy of the Ministry of Energy and Mineral Resources, the World Resource Institute (WRI), the International Energy Agency (IEA), and Carbon Dioxide Information Analysis Center (CDIAC). There may be some differences due to the different sources of data. Although the

international data are based on published national statistic and UN Statistical Office, there may be other information supplemented by other sources and estimates. In the case of CDIAC, these supplements have been subjected to professional scrutiny and debate and are consistent with other independent sources. There are a lot of graphics and charts that are developed using the Climate Analysis Indicator Tools (CAIT) Version 04, developed by the World Resource Institute.[4]

There may be some questions and arguments regarding the validity of some official data, including those from the Information Center on Energy of the Ministry of Energy and Mineral Resources. But since they are official, the study would still rely on these data. For international data, we used those from CDIAC, IEA and WRI (based on IEA statistics). They are widely referred to by the UNFCCC.

Current Status

The annual emissions in the energy sector in Indonesia reached 243 MtCO2e in 2003, according to the Ministry of Energy and Mineral Resources (Pusat Informasi Energi, 2005). Carbon Dioxide Information Analysis Center (CDIAC) in Oak Ridge, Tennessee, the United States of America (US) put the figure in the same year at 80,544 million tons of carbon, or 295.6 MtCO2e (Marland, et al., 2005). In 2004, the total emissions from the sector were 275.37 MtCO2e (See Table 2, below). This figure is 17 percent higher than the emission intensity in 1990 (see Table 6).[5]

Table 6. Comparison of Emission Data in 2004 from IEA and the PIE[7]

No.	Item	International Energy Agency	Pusat Informasi Energi
1.	GDP (billion 2000 US$)	197.18	200.357
2.	Total Population (million)	217.59	217.85
3.	Total CO2 Emission (MtCO2e)	336.32	275.37
4.	Total CO2 Emission by Fuel Type (MtCO2e)[6]		
	Coal	81.752	69.06
	Oil	181.525	155.53
	Gas	51.244	50.78
5.	Total CO2 Emission based on Sectoral Emission (MtCO2e) (2003)		
	Electricity Generation	88.91	73.44
	Industry	66.90	109.43
	Household and Commercial	83.17	27.41
	Transportation	75.51	65.06
6.	CO2 Emission Per Capita (tCO2/cap)	1.55	1.26
7.	CO2 Emission Intensity (tCO2/$ million GDP	1.705	1.37

[4] For methodology on CAIT data, please visit http://cait.wri.org/cait.php?page=notes.
[5] Please note that Figure 2 uses PPP-adjusted GDP to calculate emission intensity, not GDP, thus the different value from Table 2.

It is important to assess the status and trends of per capita and intensity of emissions in addition to the absolute emission levels. In some cases, although emission intensity is improving, total emissions could still increase when the economy grows faster than the improvement in emission intensity. In the case of Indonesia, the average improvement of emission intensity from 2000 to 2004 is 2 percent. But during the same period the economy was growing on average by almost 9 percent (Pusat Informasi Energi, 2005) and per capita emissions increased by about 1.5 percent. Total CO2 emissions in the same period increased on average by 5 percent per year. Unless emissions intensity improves faster than economic growth, total emissions will continue to rise.

Per capita emissions in Indonesia's energy sector range between 1.26 and 1.55 tons per person per year. This figure is admittedly far below global average per capita emissions at 2.1 tons per person per year. But the figure has increased by almost 150 percent since 1980, or 67 percent since 1990 (World Resource Institute, 2007). More than half – about 56.5 percent – of annual CO2 emissions was due to burning of oil,

followed by coal (25 percent), and natural gas (18.5 percent). On the other hand, emissions intensity – usually expressed as emissions per dollar of Gross Domestic Products (GDP) ranges between 1.37 and 1.71 tCO2 per million dollars of GDP.

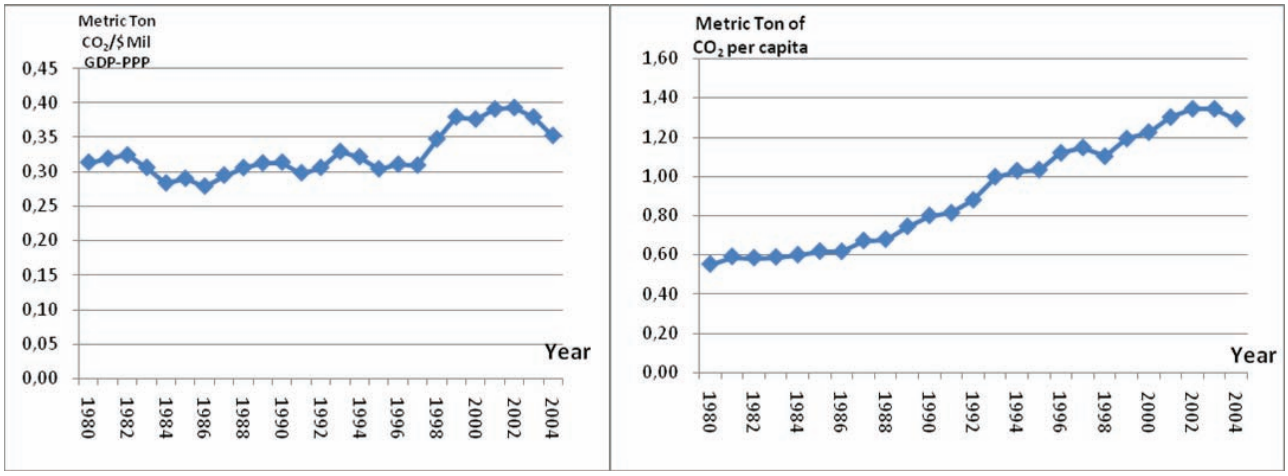


Figure 7. Indonesian per capita and intensity of emissions for the period of 1980-2004 (International Energy Agency, 2006)

[6] IEA's total emission (row no. 3) and total emission based on fuel and sectoral emission (row no. 4 and 5) are slightly different. We assumed this is because IEA include fugitive emission and other fuel combustion on their calculation on total emission (row no. 3), while total emission based on fuel and sectoral emission do not take those emission into account.

[7] The latest energy statistic from Energy Information Center, The Ministry of Energy and Mineral Resources data is available (PIE 2005), but we use 2004 data to make it comparable to those of the IEA.

The largest share – about 40 percent – of CO2 emission from energy sector in Indonesia in 2004, was from the industrial sector, followed by emissions from power plant, transportation, and household and commercial sector (26.7 percent, 23.6 percent, and 10 percent, respectively).

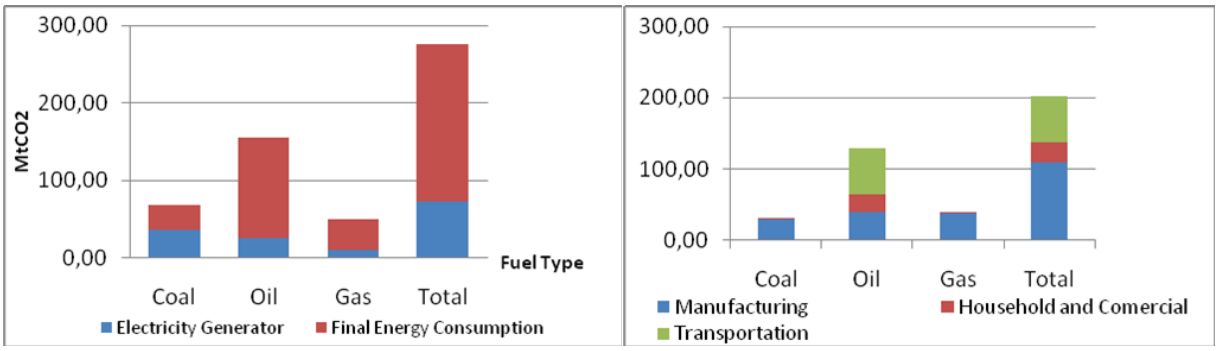


Figure 8. Indonesia's energy sector CO2 emission by fuel type, 2004, and detail of CO2 emisisons from final energy consumption by fuel type, 2004 (Pusat Informasi Energi, 2005)

While the total and per capita emissions from energy and industrial sectors are relatively small, they increase significantly. Figure , below, shows the trends of emission in the Indonesian energy sector from 1990 to 2004. In comparison to other sectors, emissions growth in the industrial sector showed significant increase during the last 7 years. In 1999 alone, CO2 emissions in the industrial sector increased by 14 percent from the previous year. These figures are almost twice the average growth from previous years. The highest increases were for coal and oil use where total energy consumption increased by 51 percent and 72 percent, respectively, from the previous year.

It was expected that the revocation of the electricity subsidy amid the economic crisis starting in 1998, resulting in the quadrupling of the price of electricity, spurred the use of subsidized primary energy such as coal and oil in the industrial sector (Baumert, et al., 2005).

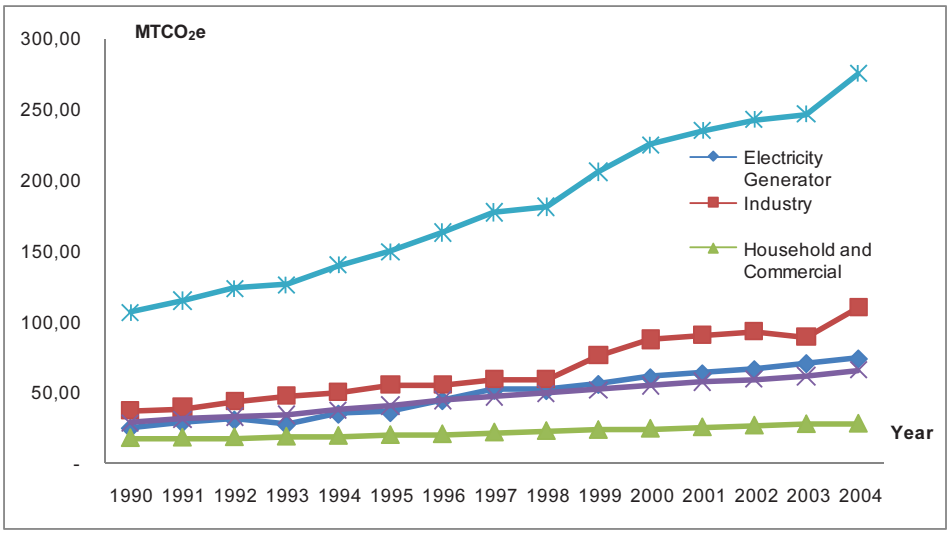


Figure 9. CO2 Emission Based on Sectoral Emission in Energy Sector (Pusat Informasi Energi, 2005)

Emissions Comparison

Indonesia's emission is still well below other comparable countries: it only accounts for 1.3 percent of the world's total. As a comparison, India, China, and the United States account for 4 percent, 18 percent, and 22 percent, respectively (International Energy Agency, 2005)

Table 7. The Comparison of Annual Emissions 2003 (International Energy Agency, 2005)

	Indonesia	India	China	United States	World
MtCO2	336.32	1,102.81	4,732.26	5,799.97	26,583.28
percent of World Total	1.26%	4.14%	17.80%	21.82%	100.00%
Emission Per Capita	1.55	1.02	3.65	19.73	4.18
Emission Intensity	1.71	1.90	2.76	0.54	0.76

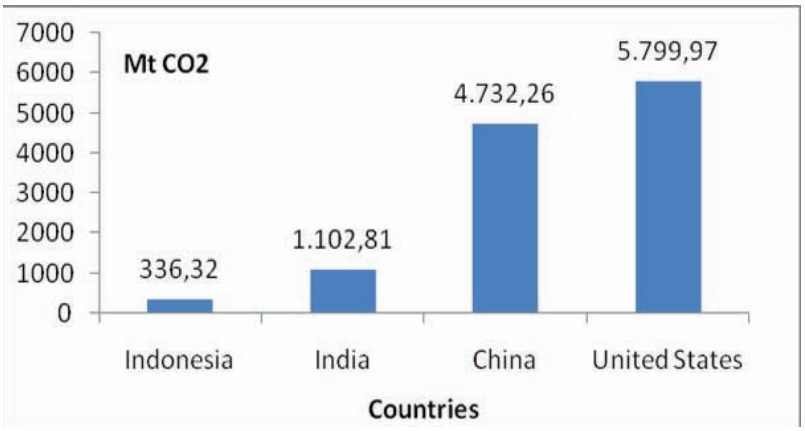


Figure 10. Annual emissions comparison (World Resource Institute, 2007)

But while total emissions are still low, emissions growth in Indonesia is higher than China and India, although still lower than in Southeast Asia. Figure 11 shows that during the period of 1990 - 2002, Indonesia's emission grew at 97 percent while China and India grew approximately 49 percent and 70 percent respectively (Baumert et al. 2005).

Emissions growth is analytically a result of the growth rates of other parameters in the economy, especially the growth of the economy (per capita GDP growth), the growth of the number of the population, the changes in the energy intensity of the economy, and the emissions intensity of the energy system. In Indonesia, final energy mix contributes 26 percent to the national emission in 2003, whereas GDP per capita, total population and energy intensity of the economy contribute 44 percent, 25 percent, and 2 percent, respectively (Baumert et al. 2005).

In China, in comparison, the significant decrease in emissions was mostly a result of the reduction of its national energy intensity. Although GDP per capita, population and fuel mix – at 122 percent, 15 percent, and 8 percent, respectively – gave positive influence toward emissions growth in China, energy intensity gave negative contributions of 96 percent toward emissions growth. As a result, total annual emissions during 1998 to 2001 were lower than those in 1996 even when, in absolute terms, the growth accounts for more than half of the worldwide CO2 increase during the 2003 – 2004 period (Baumert et al. 2005).

A Similar scenario also occurred in India. Although changes in GDP per capita, population, and fuel mix positively influenced emissions growth in India (55 percent, 28 percent, and 19 percent, respectively), energy intensity provided negative contributions of 31 percent toward the emission growth. The following figure describes the trend of GHG emission growth from 1990 to 2002 by using the CAIT –WRI tool (Baumert et al. 2005).

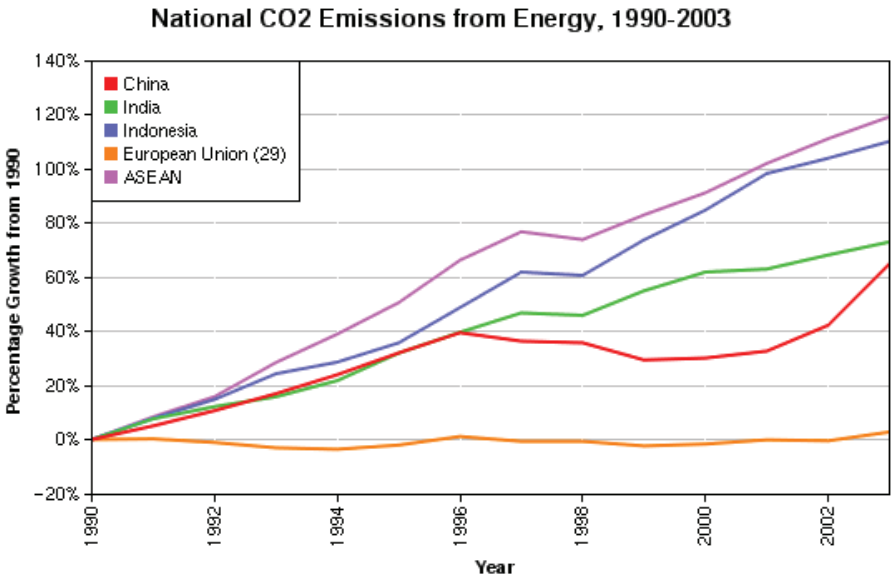
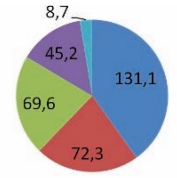


Figure 11. Comparison of National Emission Growth from Energy Sector, 1990-2003 (World Resources Institute, 2007)

Related to Figure 11, above, Figure 12, below, shows the detailed sectoral emissions from Indonesia, India and China in 2003.

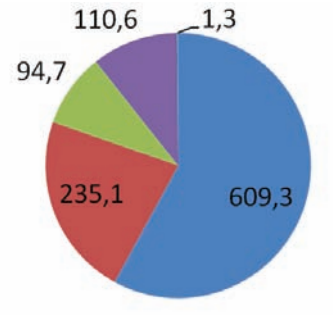
Indonesia

Sector	$MtCO_2$	%
Energy	326.9	100%
Electricity & Heat	131.1	40%
Manufacturing & Construction	72.3	22%
Transportation	69.6	21%
Other Fuel Combustion	45.2	14%
Fugitive Emissions	8.7	3%



India

Sector	$MtCO_2$	%
Energy	1,051.00	100%
Electricity & Heat	609.3	58%
Manufacturing & Construction	235.1	22%
Transportation	94.7	9%
Other Fuel Combustion	110.6	11%
Fugitive Emissions	1.3	0%



China

Sector	$MtCO_2$	%
Energy	3,719.40	100%
Electricity & Heat	2,014.50	54%
Manufacturing & Construction	1,014.90	27%
Transportation	267.3	7%
Other Fuel Combustion	422.7	11%
Fugitive Emissions	0	0%

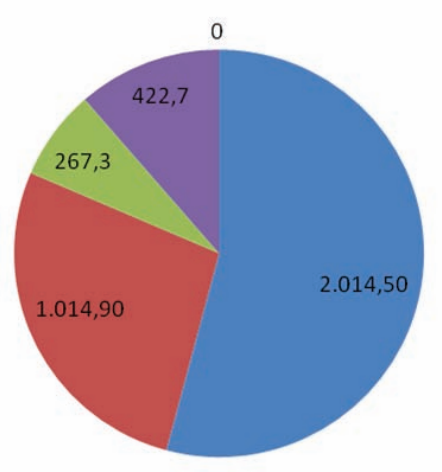


Figure 12. Sectoral CO2 Emission from India, Indonesia, China and ASEAN (World Resources Institute, 2007)

There are differences in sectoral proportions. In Indonesia, industrial sector contributes in similar proportion of emission as transportation sector does (20 percent and 21 percent, respectively). In India and China, on the other hand, transportation sector only accounts for 30 percent to 25 percent of the industrial sector (8.5 percent and 6.4 percent of total annual energy sector emission respectively). The transportation sector in India and China are improving better than Indonesia.

Per capita emission in Indonesia, India and China are far below the world average of per capita emissions. The CO_2 per capita emission in China, India and Indonesia are 2.9, 1.0, and 1.5 per person respectively (WRI, 2007). But in terms of growth, Indonesia is considered the fastest growing among the three countries. During 1990-2003, Indonesian per capita emissions have been growing annually at 4.4 percent, while India and China are 2.5 percent and 2.9 percent, respectively (WRI, 2007).

Table 8. Emission Intensity of China, India and Indonesia (Baumert, et al., 2005)

World Rank	Country	1990	2003	Change	Avg. Annual Growth	Total Growth
147	China	1,399.5	702.9	-696.6	-5.2%	-49.8%
95	India	448.9	395.0	-53.9	-1.0%	-12.0%
40	Indonesia	426.6	502.9	76.3	1.3%	17.9%

The emissions intensity of the energy system in China showed tremendous improvement (see Table 8, above). Although absolute emissions have been growing, emissions intensity decreased on average at 5.2 percent annually, or almost half the value in 1990. India emission intensity decreased at 1 percent per year. In contrast, energy intensity increased at 1.3 percent per year in Indonesia.

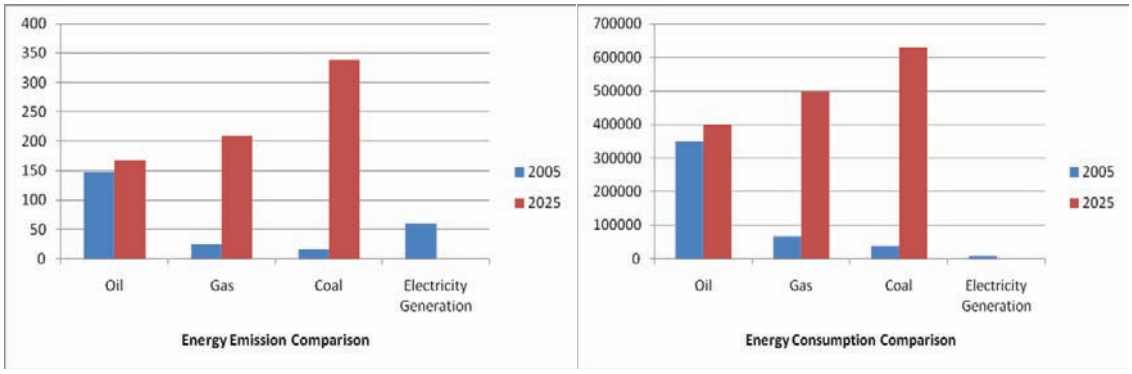


Figure 13. Indonesia Energy and CO_2 Emission: Current and Projection (Hutapea, 2007)[8]

Data in Figure 13 are higher than those published by the IEA. Energy demand in Indonesia, according to IEA, is projected to grow at 2.7 percent annually from 2002 to 2030. As energy demand from transportation sector grows at 3.8 percent annually, oil will continue to dominate the fuel mix, accounting for 38 percent of total demand in 2030. Since oil reserves are diminishing, coal demand is expected to grow up to 4.6 percent annually as power generation will increasingly utilize coal. Indeed, a disheartening trend exists: Indonesia's dependence on fossil fuels will increase from 69 percent in 2002 to 82 percent in 2030 (International Energy Agency, 2005).

As a comparison, annual growth rate of the Chinese emissions is estimated at 2.8 percent following the 2.6 percent annual growth of energy demand and 5 percent annual growth of GDP. China's share in global emissions will increase from 14 percent to 19 percent over the projection period. Annual growth rate of the Indian emissions will be around 2.9 percent annually, following 2.3 percent annual growth of energy demand and 4.7 percent annual growth of GDP. These increases will be driven by robust energy demand and continued dominance of coal in the energy mix for power generation. Power sector will remain the largest source of CO2 emissions, contributing 61 percent of total by 2030 (International Energy Agency, 2005).

AGRICULTURE AND LIVESTOCK EMISSIONS

The emission sources discussed in this section refer to Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O) from the agriculture activity such as biomass combustion, rice cultivation, enteric fermentation, manure management, soils, and other agriculture sources (i.e. shifting cultivation). The data comparison between countries uses the Climate Analysis Indicator Tools (CAIT) Version. 04 developed by the WRI.

The data mainly comes from the WRI and the US-EPA. Lack of official emission data from the government is the main problem for data comparison, as the last official data comes from the outdated 1st communication report to UNFCCC 1994.

In terms of data validity, there are differences between data results from the WRI and US-EPA regarding the agriculture emission data in 2000; this is due to different methodologies used in the calculation. For the emission projection in the future, this

[8] Electricity generation's consumption and emissions on 2025 are incorporated within oil, gas and coal consumption & emission.

study is using the US-EPA data series from 1990 to 2020; however, there are no other official data available to determine the accuracy of the projection.

Current Status

In Indonesia, the agriculture sector is the main source of methane emissions as it accounts for 59 percent of total national emissions. Rice cultivation emits about 70 percent of CH_4 emission and 86 percent of total nitrous oxide (N_2O) emissions. World-wide, agriculture sector is the largest contributor of non-CO_2 GHG emission which accounts for 59 percent in 1990 and 57 percent in 2020 (US Environmental Protection Agency, 2006). Meanwhile, according to WRI, the agriculture sector contributes approximately 15 percent of global total emission, in which the highest released is N_2O from soil, comprising of 48 percent from total emission of agriculture sector (Baumert, et al., 2005).

As an agricultural country, agriculture emissions have significant contribution to national GHG emission, which is largely contributed by rice cultivation activities. Methane emission in the agriculture sector is mainly due to inefficient practices such as over-irrigation, misuse of fertilizer and poor live-stock feeding practice (IGES, 2005). Flooded rice cultivation, as the most common practice among farmers in Indonesia, releases CH_4, N_2O, and CO_2 to the atmosphere. In addition, GHG emission might be generated through a number of other agriculture practices (i.e. shifting cultivation).

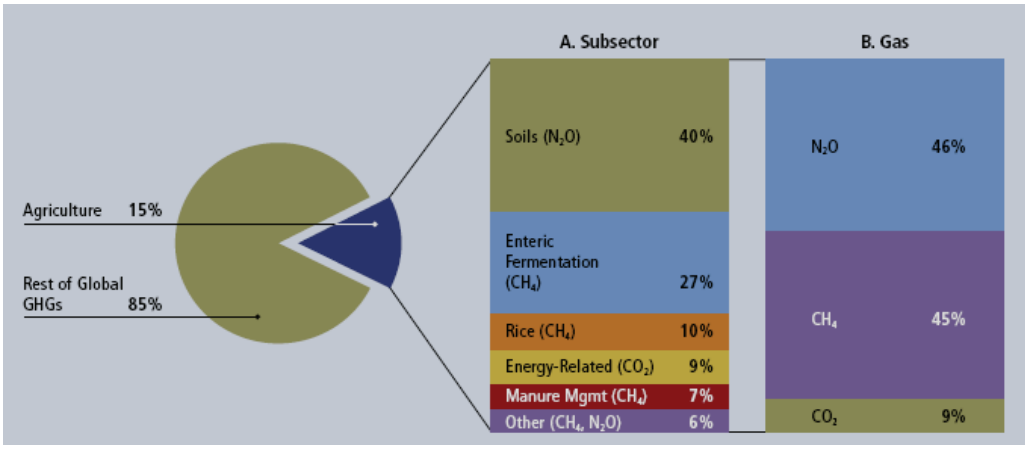


Figure 14. Global Agricultural and Livestock Emission (Baumert, et al., 2005)

Comparison to Other Countries

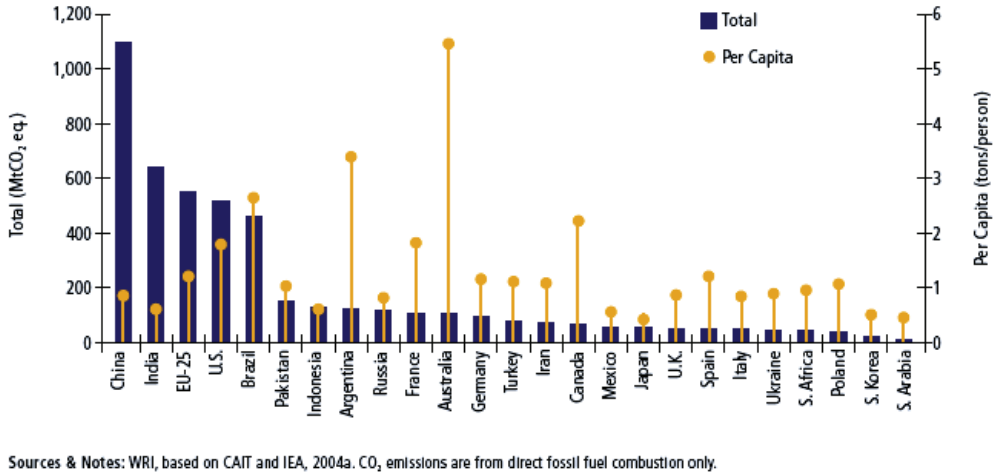


Figure 15. CO2 from Agriculture, Total and Per Capita, 2000 (Baumert, et al., 2005)

According to Las et al, 2006, 8.5 million hectares area of paddy field and tidal swamp farming in Indonesia contribute significantly to agriculture GHG emission. Several studies conducted in the 1990s estimated methane emission ranging from 3.20 to 5.80 Tg/year (Taylor et al, 1993) while other stated 9.80 Tg/year (Bachelet and Neue, 1992; Husin, 1994). International Rice Research Institute and Indonesian Agriculture Research and Development Agency estimated that methane emission from paddy field accounts for 12 percent of total national methane emission (Makarim et al, 1996).

Another study in 1997 conducted by ALGAS estimated that agriculture emission produced 3.363 Tg of CH_4 annually, where 75 per cent was emitted from the rice fields (ALGAS, 1997). These high emissions are mainly the result of inefficient agricultural practices. The study also projects that methane emission from rice field will increase at the rate of 1.8 percent while livestock is 3.4 percent per year.

The Climate Analysis Tools developed by World Resource Institute developed the following table that provides information on agriculture emission from several Asian countries.

Table 9. Agriculture Emission Comparison in 2000 (World Resources Institute, 2007)

Country	Agriculture Emission (in $MtCO_2e$)	Percentage to Total CH_4 and N_2O Emission
Indonesia	123.0	59.2 %
China	1,008.5	69.9 %
India	639.3	77.2 %
ASEAN	369.2	62.4 %
Brazil	446.0	88.1%

The table above show that Indonesia emission accounts for 33 percent of ASEAN total agriculture emission. However, compared to India and China, Indonesia emission is still below their emissions.

In Brazil, India and China, urban population growth and increase in per capita income are expected to lead to an increase in livestock product demand, domestic livestock population and thus methane emissions (US Environmental Protection Agency, 2006). According to the study, in regards to methane emission from rice cultivation, Indonesia, together with China, India and Thailand, Vietnam and Myanmar, contribute 78 percent of world emissions from rice cultivation. The agriculture emission from Indonesia, Brazil, China and India is available in Figure .

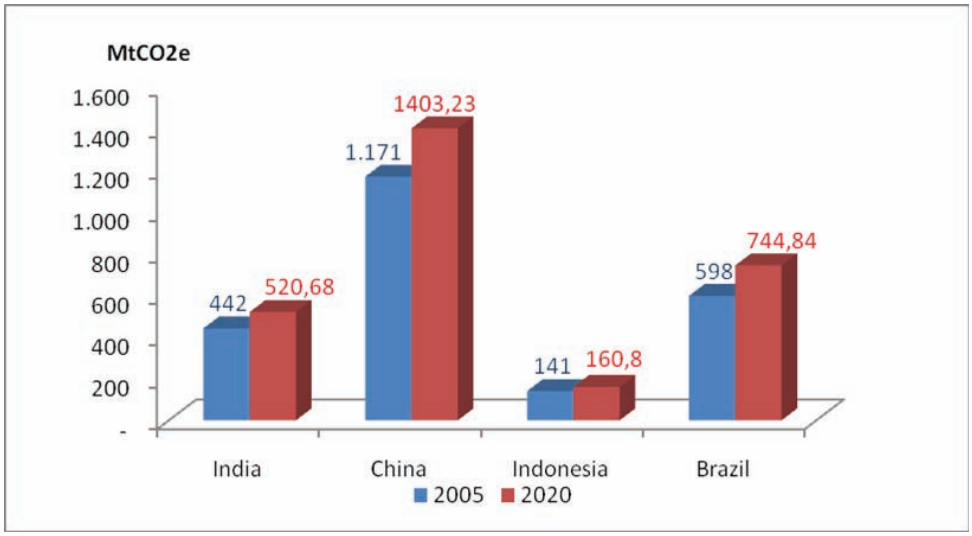


Figure 16. Agricultural Emission Projection (US Environmental Protection Agency, 2006)

The above figure also projects agriculture emissions to 2020. In 2020, Indonesian emissions will grow 14 percent from the emission in 2005. China, India and Brazil emissions in 2020 will grow 20 percent, 18 percent and 25 percent compare to the emission in 2005, respectively. Annually, Indonesian emissions grow at 1 percent, while China, India and Brazil are 1.3 percent, 1.2 percent and 1.6 percent, respectively.

There are some differences between the agriculture emission data from WRI and the data from US-EPA in 2000; this is because of the different methodologies used in the calculation. The US EPA projects a bigger number than WRI because they include all the methane and nitrous oxide sources from biomass combustion, rice cultivation, manure management, soils, and other agriculture sources.

WASTE EMISSIONS

Emissions that are discussed in this section come from solid waste (i.e., landfills), waste water treatment and human sewage as used in many sources such as CAIT and USEPA 2006. Other sources of waste such as manure management, enteric fermentation, and many others are included in the agriculture and livestock sector emission section. The discourse covers total emission, distribution emission by source and also emission per capita which is significant to be discussed because it can reflect waste generation rate.

The data is mainly from USEPA 2006 and WRI simply because there is no recent data concerning waste sector emission from other sources. There is no update data from Government of Indonesia except the outdated 1st Communication report in UNFCCC. GHG emission inventory from other International organization such as UN Statistics Division, UNEP-GeoPortal and RIVM-EDGAR all refer to the same 1st Communication report. Thus they are not used in the report.

In terms of data validity, there is significant uncertainty regarding emission factors. Both WRI and USEPA reports acknowledge high uncertainty in estimating the numbers.

Current Status

According to KLH 2001, there were about 63 major landfills in Indonesia. In terms of solid waste management, only two are controlled landfills and the rest are open dumps (Ministry of the Environment, 2004).[9] Lack of solid waste management for landfills accounts for the volume of emissions that result from methane gas production due to anaerobic decomposition of organic material in landfills. Wastewater-based emissions come from untreated domestic wastewater and industrial wastewater. The pulp and paper, food and beverage, chemicals and textile sectors together account for over 90 percent of BOD effluent generation (WDI 2001, cited from World Bank 2003). In terms of domestic wastewater in general, Indonesia has one of the lowest rates of sewerage and sanitation coverage throughout Asia (The World Bank, 1997).[10] In 2000, there were only 57.41 percent from total population who had access to on-site processing of domestic waste water (BPS 2000, cited from KLH 2003).

Based on USEPA (2006) report and WRI-CAIT, Indonesian GHG emission from waste sector in 2000 ranged from 32.35 - 59.8 $MtCO_2e$. For the same year, WRI-CAIT ranks Indonesia as the 6th largest GHG emitters in waste sector.

According to USEPA, waste comprises 3 category of landfill (CH_4), wastewater (CH_4) and human sewage (N_2O) whilst WRI-CAIT do not specify waste sector category in their waste sector. The largest source of emission – which emits CH_4 - comes from handling wastewater, which is about 65 percent from total waste sector emission. In 1990, Indonesia ranked as the fourth of largest wastewater emitters in the world (US Environmental Protection Agency, 2006). The second largest is solid waste / landfill emission, which emits CH4. The smallest part belongs to treatment of human sewage which emits N_2O (US Environmental Protection Agency, 2006).[11]

When total emission is compared to the total population, the emission per capita are in range of 0.158 – 0.29 tCO2/capita in 2000 which illustrate slight increase from 1990. In comparison with GHG emitters in waste sectors, Indonesia is among the top 15 GHG emitters for emission per capita (Baumert, et al., 2005).

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[9] Control landfill is Indonesian term of semi sanitary landfill – open dumping application. World Bank 1999 classifies control dump as landfill in which registration and placement/compaction of waste take place, but there is no engineering measures, no leachate management and landfill gas management.

[10] As cited from Indonesia Environment Monitor 2003 (World Bank 2003).

[11] Methodology: For landfill using First Communication data and IPCC tier 1 methodology for estimation and projection, for wastewater and human sewage using IPCC tier 1 methodology for both estimation and projection. CAIT version 4; Methodology: DRAFT Emissions and Projections of Non-CO2 Greenhouse Gases for Developing Countries: 1990-2020 (USEPA 2002), DRAFT Global Anthropogenic Non-CO2 GHG Emissions: 1990 – 2020. Thus USEPA 2006 is more applicable in the report because it include details of emission sources and it attempts to estimate beyond Indonesian 1st National Communication Report.

Table 10. GHG Emission from Waste Sector (US Environmental Protection Agency, 2006) (World Resources Institute, 2007)

Indonesia (in $MtCO_2$)	1990	1995	2000	2005
USEPA 2006	27.79	30.12	32.35	34.51
• **Solid Waste Emission**	7.80	8.44	9.05	9.64
• **Wastewater Emission**	18.01	19.51	20.94	22.25
• **Human Sewage Emission**	1.98	2.17	2.36	2.62
Emission per Capita	0.156	0.155	0.158	0.157
WRI-CAIT	50.6	55.3	59.8	n.a.
Emission per capita	0.28	0.28	0.29	n.a.

Comparison to Other Countries

Growth rate of waste emissions in Indonesia, China and India is relatively stable. When compared to India and China, Indonesia is positioned in the middle of those countries in terms of waste emission growth rate within a 30 year span. Emission growth rate of Indonesia is 1.2 percent, whilst India has growth rate of 1.49 percent and China of 0.73 percent.

In terms of waste emission size, Indonesia emits smaller GHG emission than both India and China. In 2000, Indonesian emission was 32.46 MtCO2 while India and China had emissions of 3.5 and 5 times respectively higher than Indonesia (US Environmental Protection Agency, 2006).

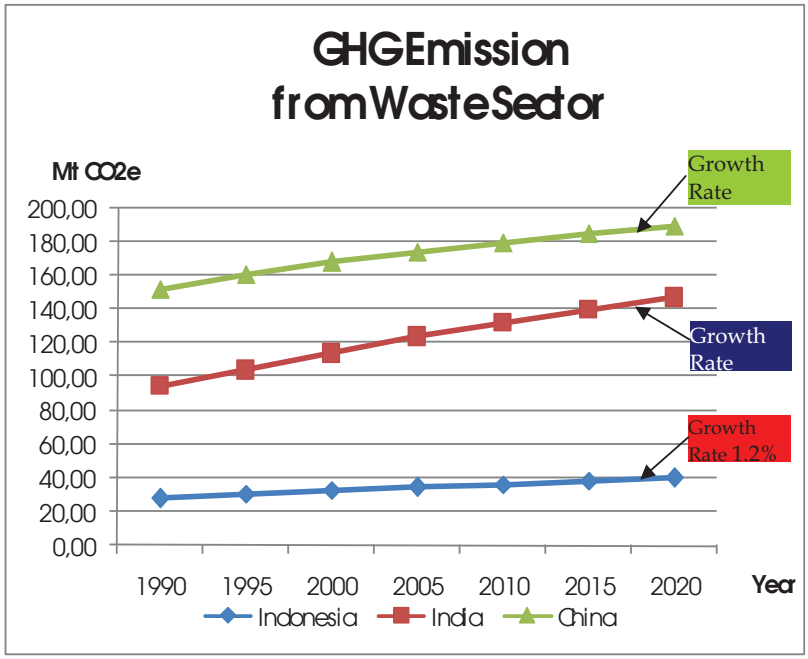

Figure 17. GHG Emissions from Waste Sector (US Environmental Protection Agency, 2006)

The illustration below shows the emission per capita in three countries. It can be seen that Indonesia has a higher emission per capita than both India and China. It reflects either a high waste generation per person or less advanced waste treatment in Indonesia.

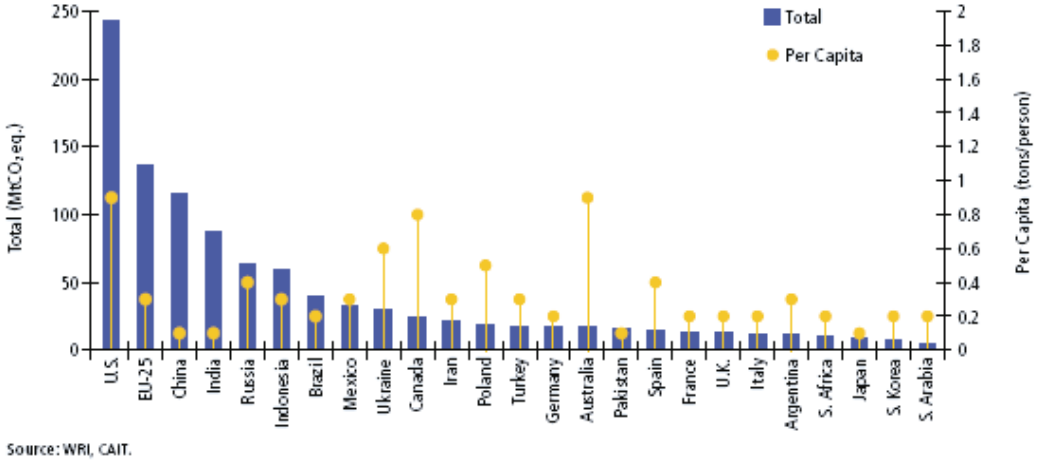

Figure 18. Waste Emission Per Capita (Baumert, et al., 2005)

Trend and Projection of GHG emissions

The driving factors for landfill emissions trends are population growth , increases in personal incomes, and expanding industrialization, all of which can lead to increases in the amount of waste. Another factor is the status of waste management technology. Emitted CH_4/N_2O will increase when less advanced waste treatment technology is applied.

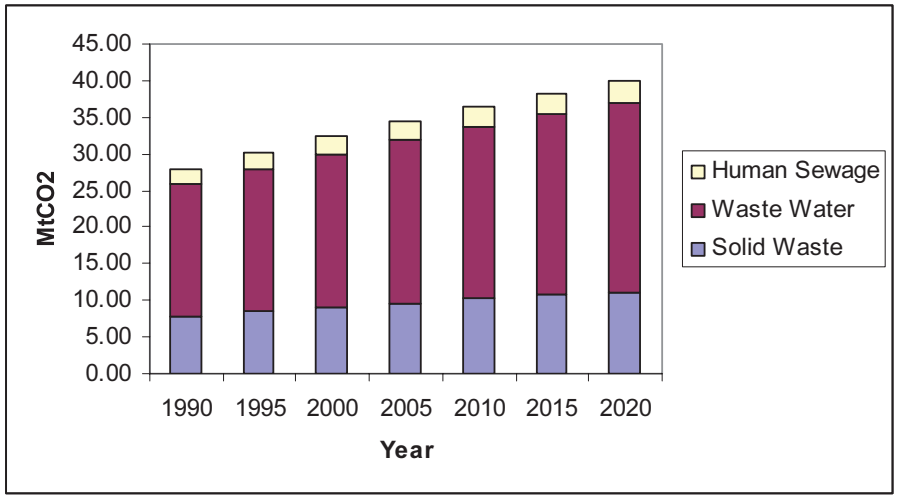

Figure 19. Indonesian Waste Emission (US Environmental Protection Agency, 2006)

According to USEPA report, emission from waste sector in Indonesia will increase slightly with the growth rate of 1.2 percent. The growth rate is smaller than the estimation based on KLH's 2003: National Strategy Study on CDM in Forestry Sector, which is almost 2 percent per year (NEDO, 2006). Despite the overall increase rate in 30 years span, the percentage of increase is actually decreasing every five years. For illustration, there was 8.3 percent increase from 1990 emission in 1995, 7.3 percent increase in 2000, up to 2020 which illustrate only 4.6 percent increase from 2015. The decrease may result from the expectation of increasing of waste management. The projected emission in 2020 amounts to 40.07 $MtCO_2e$ (US Environmental Protection Agency, 2006)

Contribution of each sub-sector remains the same from 1990 to 2020. Emissions from waste water dominates the source of emissions which is followed by emissions from solid waste and human sewage.

GLOBAL COMPARISON

Indonesia has become one of the three largest emitters of greenhouse gases in the world (see Table 11 and Figure 20). This is largely due to the significant release of carbon dioxide from deforestation. Annual emissions in Indonesia from energy, agriculture and waste all together are around 451 million tons of carbon dioxide equivalent ($MtCO_2e$). Yet land-use change and forestry (LUCF) alone is estimated to release about 2,563 $MtCO_2e$ – mostly from deforestation, as estimated by the IPCC (Houghton 2003, cited in Baumert *et al*. 2005). While data on the emissions from different sources vary between studies, the overall conclusion is the same. Indonesia is a major emitter of GHGs.

Table 11. GHG emissions summary ($MtCO_2e$) [1]

Emissions sources	United States	China	Indonesia	Brazil	Russia	India
Energy[2]	5,752	3,720	275	303	1,527	1,051
Agriculture[3]	442	1,171	141	598	118	442
Forestry[4]	(403)	(47)	2,563	1,372	54	(40)
Waste[5]	213	174	35	43	46	124
Total	**6,005**	**5,017**	**3,014**	**2,316**	**1,745**	**1,577**

Note: (1) The table excludes EU from the comparison as EU comprises 25 countries. If EU as a block enters the calculation, Indonesia stands 4th, and the ranking are US, EU, China and Indonesia. (2) The data for energy emissions are from 2003. The energy data used IEA's 2005 annual statistics except for Indonesia where PIE 2005 statistics are used. (3) The data for agriculture emissions are from 2005, from US EPA 2006. Biomass combustion is included in the calculation. (4) The data for

forestry (LULUCF) emissions are from 2000, from Houghton 2005. (5) The data for waste emissions are from 2005, from US EPA 2006.

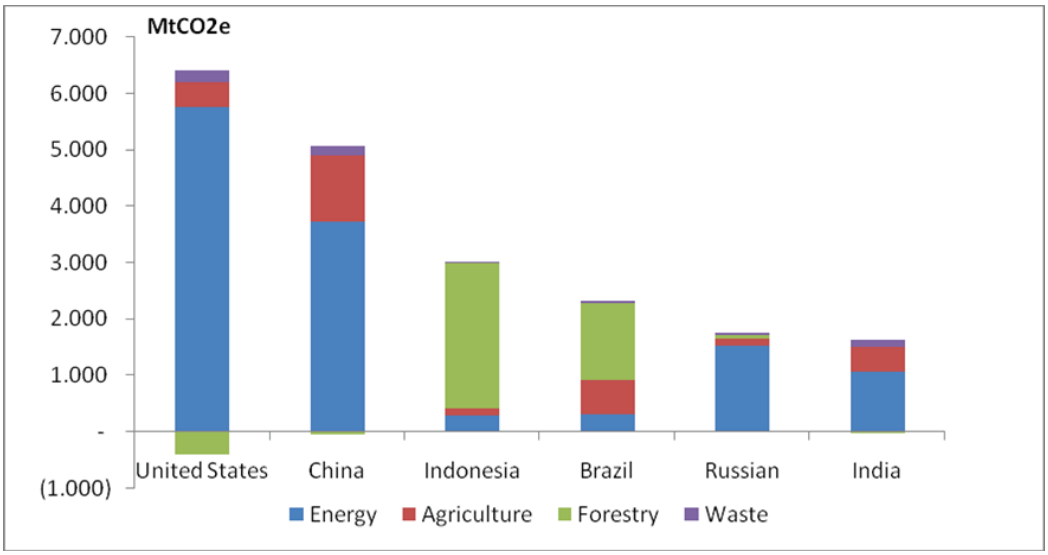

Figure 20. Global Comparison

Figure 20 shows the composition of annual GHG emissions from the tops 6 countries. If the United States, China, Russia and India are among the largest emitters due to their energy consumption, Indonesia and Brazil were different. Land use, land use change and forestry are major contributors GHG emissions from these countries. Reducing energy emissions by promoting energy efficiency and renewable energy will be relatively insignificant in these countries, since more than 80% GHG emissions are from deforestation.

As for emissions projections, by 2025 developing countries will be responsible for 55 percent of global emissions as the emissions will rise by 84 percent. China is projected to surpass the United States as the world's largest global emitter.

4. IMPACTS OF CLIMATE CHANGE IN INDONESIA

Global warming is a phenomenon where the increased concentration of GHGs traps the energy from the sun in the atmosphere and thus leads to earth's temperature increase. There is growing scientific evidence that the earth is warming and it is due to human activities. In general, Indonesia, partly situated along the equator, will experience modest temperature increase.

This modest temperature increase will nevertheless result in a number of impacts. First, the rise of temperature will significantly affect the hydrological cycle. It will alter evaporation, transpiration, run-off, soil moisture, and in turn precipitation. As a result, in a warming world, there will be increased intensity of rainfall, but in shorter periods due to prolonged dry seasons (thus, fewer rainy days per year but more intensity in a year – thus even more so for every rainy day).

A prolonged dry season will lead to more intense droughts. Eventually this will also pose serious problems for agriculture, and, combined with increased intensity of rainfalls, increase the risks of flooding. The decreased crop production – due to changes in soil moisture, hydrological cycle, and prolonged droughts – will likely threaten food security. Moreover, since 46 percent of employment is in the agricultural sector which still generates 16 percent of total GDP (Ministry of Man Power and Transmigration, 2007), significant employment and livelihoods problems will also occur.

Warmer climate will also increase the average temperature of ocean water – so called "ocean warming". With two thirds of the country's area being ocean water, the fishery sector as well as marine biodiversity will likely be affected by ocean warming resulted from climate change.

Additionally, ocean warming and the melting of glaciers and polar ice caps will increase the risks from sea-level rise that in turn will likely to cause inundation of productive coastal zones, such as those studied in the Jakarta Bay area. In turn, sea-level rise and increased temperature will lead to the reduction of farming and coastal livelihoods such as mangroves, although the scale of this has yet to be understood. Ocean warming is believed to be responsible for coral bleaching, a

phenomenon that threatens the marine and fisheries sectors, given the fact that coral reefs are home to thousands of varieties of marine species.

Warmer climate is also associated with outbreaks of tropical diseases such as malaria, dengue and plague. Impacts will be uneven across the country, but result in significant economic damage and loss of livelihoods.

There are events in which climate variability – not climate change – has caused higher-than-usual temperatures in Indonesia. For example, the 1998 El Nino events (which put 1998 as the hottest year in the century) affected a large extent of the Indonesian ecosystems in such a way that would be predicted in the occurrence of climate change. But while any correlation between climate variability such as El Nino and climate change cannot be easily established or implied, it is safe to say that the impacts of El Nino (and the following La Nina) could serve as anecdotal proxies to the possible impacts of climate change in the event of a warming world. Indeed, average temperature as high as those observed in El Nino years will be more of a permanent event, instead of an exception such as now.

This section of the paper deals with the ecological as well as socio-economic impacts of climate change on Indonesia. It begins with the risks of temperature increase.

TEMPERATURE INCREASE

Global average surface temperature has increased by 0.6 ^{o}C since late 1950s. Projections by the Intergovernmental Panel on Climate Change (IPCC) show temperatures rising during this century by 1.4 – 5.8 ^{o}C. For the next two decades, a warming of about 0.2 ^{o}C is projected for a range of emission scenarios assessed by Working Group I of the Fourth Assessment Report of the IPCC. But even if the concentrations of GHGs and aerosols had been kept constant at the 2000 levels, a further warming of about 0.1 ^{o}C per decade would be expected.[12] As current trends show, the temperature increase may be close to the upper end of the projected range (IPCC 2007).

[12] Even though emissions are instantly reduced to zero at year 2100, it takes about100 to 400 years in the different models for atmospheric CO_2 concentration to drop from the maximum (ranges between 650-700 ppm) to below the level of two times preindustrial CO2 (560 ppm) owing to a continuous transfer of carbon from the atmosphere into the terrestrial and oceanic reservoirs.

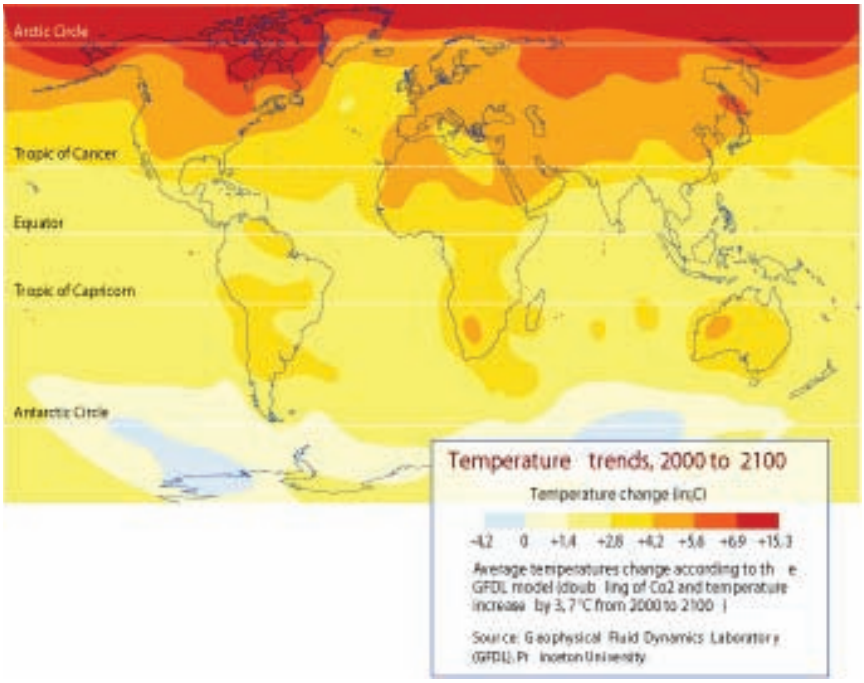

Figure 21. Temperature Trends Under GFDL Scenario, 2000 to 2100 (UNEP/GRID-ARENDAL, 2005)

By using GFDL model (doubling of CO_2 and temperature increase by 3.7°C from 2000 to 2100), the picture above shows modeling the average temperatures changes in the world. On average, Indonesia will experience up to 2.8°C increase across the country (UNEP/GRID-ARENDAL, 2005).

Future temperature increase was calculated by using a simple climate model created from a combination of the SRES scenarios and climate sensitivity (i.e. B1-low, B2-mid, A1-mid and A2-high). The air temperature in Indonesia will increase rather slowly in the future compared to the global average, with a rate in a range between about 0.1°C/decade for the B1-low scenario and 0.3°C/decade for the A2-high scenario compared to the global average, which is in a range between 0.1°C/decade for the B1-low and 0.4°C/decade for the A2-high. This rate of warming is quite uniform throughout the year for the whole region, including Java, and is quite comparable to the rate of increasing trend of temperature data from 12 selected climate stations in Indonesia which is between 0.2 and 0.4°C/decade since 1970 (De Rozari, 1993).

1980s	1990s			2020s			2050s			2080s	
Temp. degC	Temp. degC		CO_2 ppmv	Temp. degC	Sea-level cm	CO_2 ppmv	Temp. degC	Sea-level cm	CO_2 ppmv	Temp. degC	Sea-level cm
0.13	0.28	B1-low	421	0.6	7	479	0.9	13	532	1.2	19
0.13	0.28	B2-mid	429	0.9	20	492	1.5	36	561	2.0	53
0.13	0.28	A1-mid	448	1.0	21	555	1.8	39	646	2.3	58
0.13	0.28	A2-high	440	1.4	38	559	2.6	68	721	3.9	104

Figure 22. Changes in the Global Environment in Indonesia (Hulme, et al., 1999)

Indeed, annual mean temperature has increased by about 0.3°C since 1990. The 1990s was the warmest decade and an increase of almost 1 °C above 1961 – 1990 average in 1998 was the warmest year of the century. The temperature increase has occurred in all seasons of the year (Hulme, et al., 1999). The above picture summarizes the changes in the global environment by 2020s, 2050s, and 2080s under four scenarios. Changes are calculated with respect to the 1961-1990 average (ibid).

Changes in Seasonal Cycle and Rainfall Patterns

The figures below are images compiled from several official observations by the Meteorological and Geophysics Agency (Badan Meteorologi dan Geofisika, BMG) of wet and dry season anomalies from 1990 to 2003 compared to those in 1930 to 2003. The two figures below show the variance in the wet and dry seasons across Indonesia. There are regions in which the wet season shifted forward by 60 days, such as those in West Sumatera, Jambi, Jayapura, and Merauke. Conversely, there are regions where the wet season shifted backward more than 30 days such as those in Banten and Jakarta. Some regions, however, such as Ujung Kulon, Ujung Pandang, Madiun, Malang, Kediri, Pacitan, Gresik, Tuban, and Blitar, did not show any variance at all (Ratag, 2007).[13]

[13] A projection of temperature increase in Indonesia to 2020 exists and a series of results from such modeling exercise was presented to the authors of this paper. However, the owner of the modeling results – associated with a public university in Indonesia – decided to withdraw his permission to make use of the results, hence the exclusion of those projections from this paper.

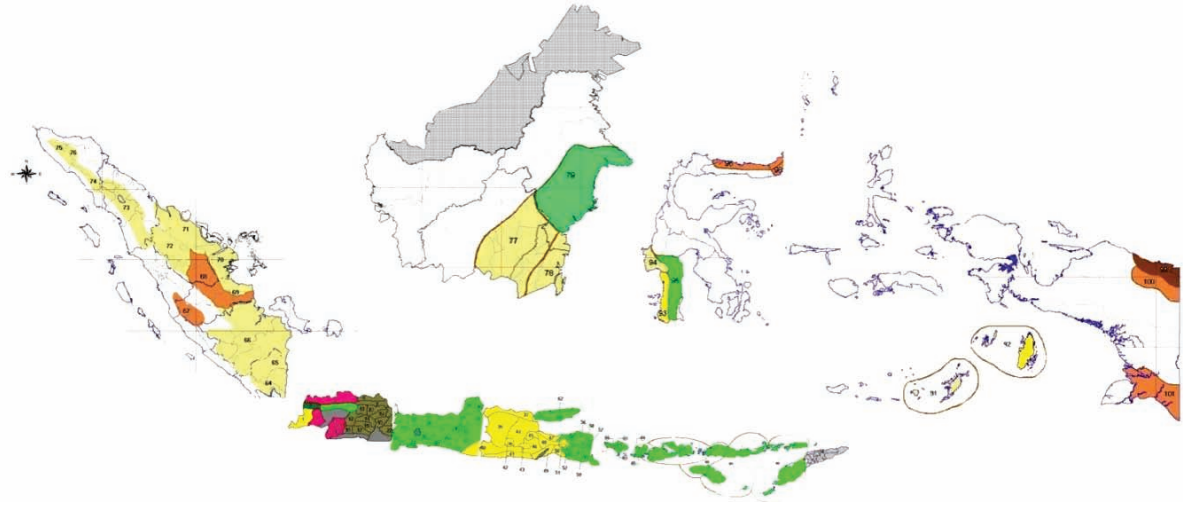

Figure 23. Wet Season Anomaly From 1990-2003 Compared to 1961-1990 Period (Ratag, 2007)

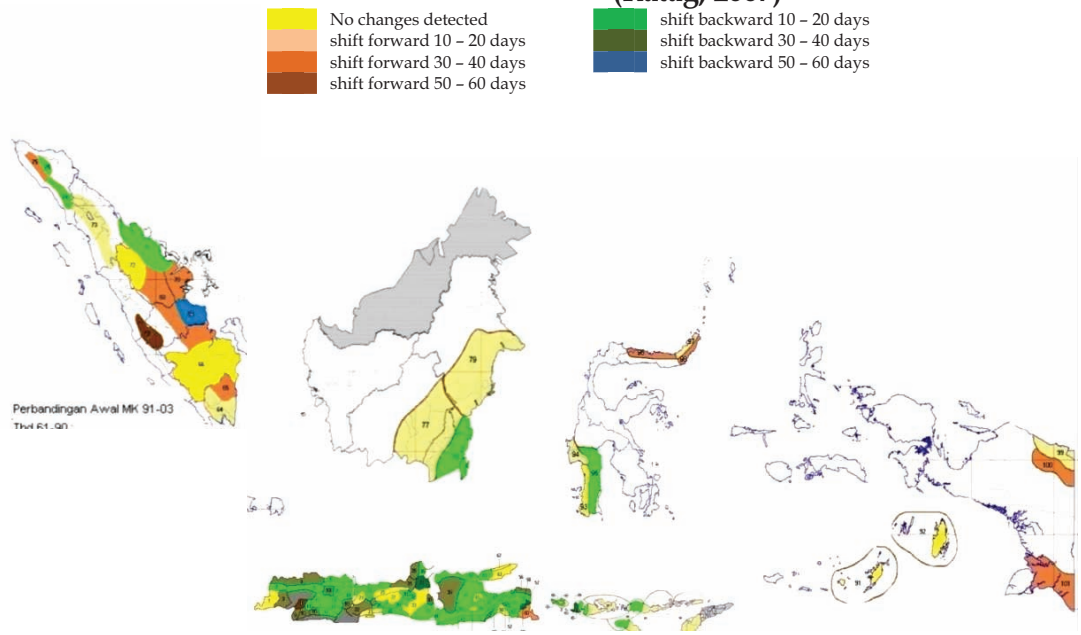

Figure 24. Dry Season Anomaly from 1990-2003 Compared to 1961-1990 (Ratag, 2007)

A report from the United States National Aeronautics and Space Administration (NASA) concludes that the event of El Nino Southern Oscillation (ENSO, or El Nino) causes changes in rainfall patterns around the world. Using the Tropical Rainfall Measuring Mission (TRMM) satellite, researchers tried to identify areas where the year-to-year changes in rainfalls between 1998 and 2003 was greatest. The researchers then compared local changes in worldwide rainfall. For years, scientists have known El Nino to drastically modify rainfall patterns in many regions. For example, Indonesia consistently suffers droughts during El Nino and excessive rains during La Nina (National Aeronautics and Space Administration, 2007). Unfortunately, current understanding of El Nino and the climate system does not allow scientists to conclude whether any recent increase in intensity of El Nino is the result of anthropogenic global warming, or whether the observed rise in global surface temperature is due to a naturally-enhanced El Nino. What can be learned from the El Nino event is that a warming Earth – either naturally due to El Nino or anthropogenically due to climate change – will increase the risks of significant changes in rainfall patterns and others.

Scientists generally agree that global warming associated with climate change will result in longer dry season and shorter but more intense wet season. It is predicted that Indonesia will have 2 percent to 3 percent more rainfall each year (Ratag 2001). Another prediction states that there is expected to be an increase in the amount of rainfall, which is indicated by positive anomaly and changes of rainfall zones, increase in temperature and evaporation, especially on the Malaka and Karimata Straits, Banda, and Arafura Oceans. This observation use rainfall data from 1950 to 1979 to simulate rainfall zone anomaly from 2012 to 2039. Changes in the intensity and quantity of rainfalls, particularly those of 100 – 150 mm per day, are significant (59 – 100 percent) at Tamanbogo and Genteng stations from 1991 to 2000. Figure below shows the average changes of precipitation from the period of 1900 – 2000, for September – November and for December – February (Ratag, 2007).

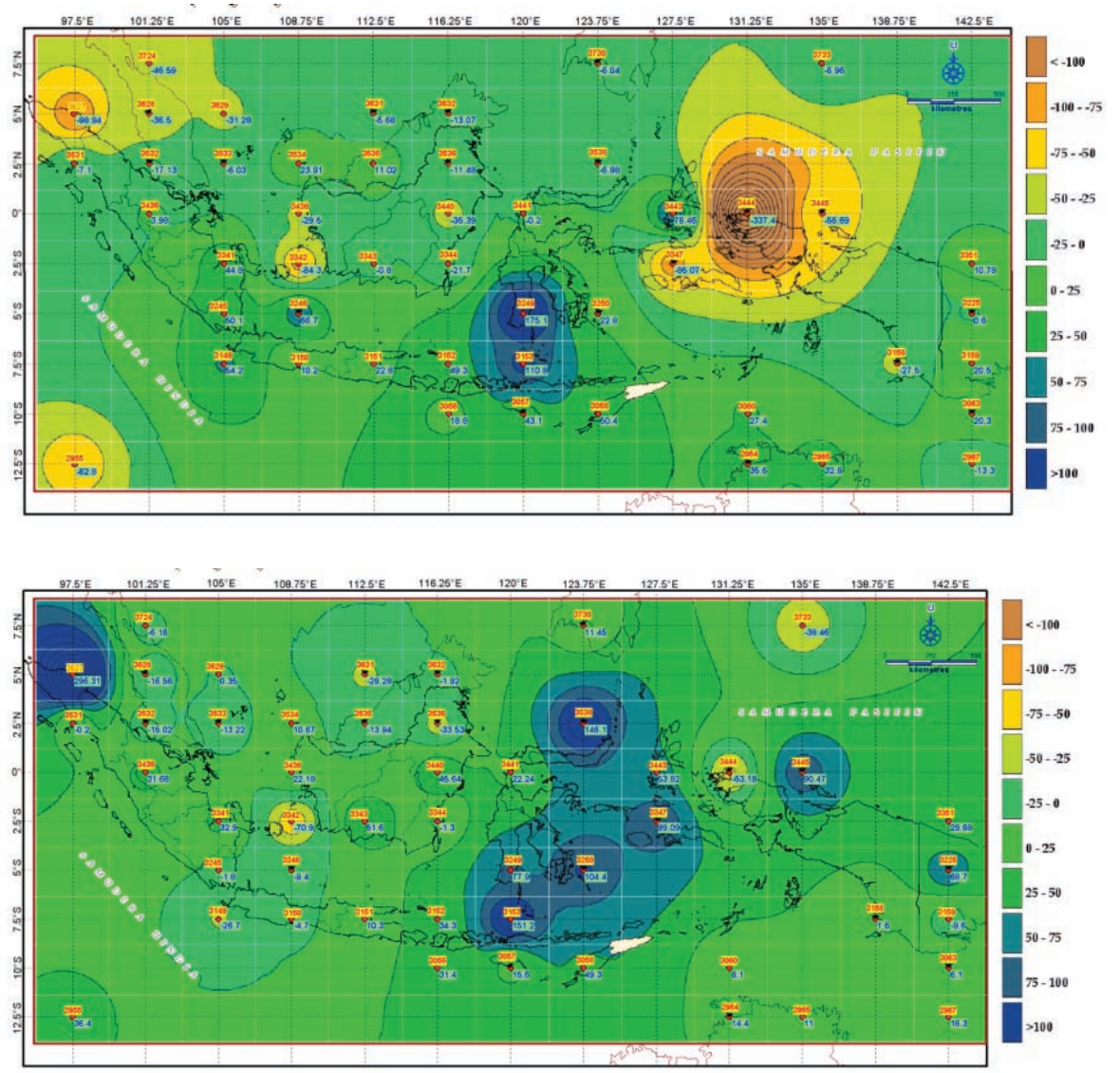

Figure 25. The Average Change of Precipitation from the period of 1900-2000 in mm/100 years, for September - November (above) and December - February (below) (Ratag, 2007)

Impacts on Water Resources

One of the most significant impacts of climate change, especially warming climate, is the disruptions of the regional hydrological cycle, with implication for the quantity

and quality of regional water resources (Irianto, et al., 2004). The impacts on the hydrological cycle will cover sedimentation, run-off, deep water, and water resources (the impacts on water resources will include municipal water supply, reservoir, and irrigation).

Prolonged dry season and shifted or increased anomalies of dry and wet seasonal cycle – sometime unpredictably – can reduce the quantity and quality of water resources (Irianto, et al., 2004). A study implies that a doubled atmospheric concentration of CO_2 (from 275 parts per million, ppm, prior to the industrial revolution to about 550 ppm before the end of this century) without any change in land use will cause a decrease in almost all hydrological balance parameters in two observed watersheds in South Sulawesi, and only evapotranspiration will increase (IPB, 2000).

Another model-based prediction provides different result, however. This model predicts that the hydrological balance parameters will increase under the doubled CO_2 concentration. The same study finds that global warming, coupled with land use, change will cause Walanae Hulu watershed and Saddang watershed to be in an "alert" status using CSIRO9 model and "critical" using GFDL model. "Alert" status indicates the total water demand being in the range between 10 percent and 45 percent of the low-flow conditions and "critical" status indicates the total water demand being in the range between 25 percent and 45 percent (Kaimuddin, 2000).

To adapt to this difficult situation, some actions that are recommended by the government and affected people include: integrated water resource planning and management, enhanced database and information dissemination of hydrological resources, water conservation, efficient and rational use of water in agriculture sector, and enhanced capacity of affected people (Irianto, et al., 2004)

Impacts on Agriculture Sector and Food Security

The combination of increased average temperature, a disrupted hydrological cycle in terms of prolonged dry season and a shorter but more intense wet season, increased anomaly of dry and wet seasonal cycle, and reduced soil moisture will disrupt the agriculture sector and eventually food security. Although the magnitude or direction of impact for individual countries or regions remains uncertain, climate change is expected to affect crop yields and agricultural production. Some impacts are biophysical, ecological and economic. Climate impacts on agriculture include: a shift in climate and agricultural zones towards the poles, changes in production patterns due to higher temperature, a boost in agricultural productivity due to increased CO_2 in the atmosphere, changing

precipitation patterns and increased vulnerability of the landless and the poor (UNFCCC, 2002)

A study concludes that climate change has the potential to change the productivity of agriculture significantly in most locations. Some highly productive areas may become much less productive while some marginal areas may benefit. Most areas can expect changes, however, and will need to adapt but the direction of change cannot be straightforwardly predicted. According to the same study, pole regions will likely to gain while subtropical and tropical regions may be more likely to suffer drought and losses in productivity. In turn, food security will be affected and feeding the growing number of population will be a challenge (Reilly, 1996)

Using the doubled CO_2 concentration agricultural projections, changes in crop yields in the Asian region will vary between -22 percent to +28 percent by 2100 (Reilly, 1996). In Indonesia, the doubling of CO2 concentration in the atmosphere could be positive or negative. It may be an advantage as it will support the photosynthesis process. Solar radiation will have positive impacts while the rise in temperature will likely be disadvantages to in Indonesia's agricultural practices. The change of rain pattern will have either a positive or negative effect, depending on geographical location. This requires further research. A modeling simulation using Crop Model developed by the Goddard Institute of Space Studies (GISS), UK Meteorological Office shows a decrease of crop harvest in West Java and East Java as a result of climate change (Amin, 2004).

Mean temperature and rainfall patterns are critical variables in the agricultural sector. Studies suggest that rainfall will increase by 7 to 33 percent in the Citarum watershed, 8 to 50 percent in the Brantas watershed, and 8 to 56 percent in the Sadang watershed, accompanied by slight temperature changes of 0.03 to 0.04 ^{o}C throughout the archipelago. The additional rainfall can augment water supplies for irrigation by 30 percent, 30 percent, and 130 percent, respectively. Conversely, more rapid siltation is likely to reduce the lifetime of reservoirs and irrigation canals. Increased precipitation may also accelerate soil erosion; increases in rainfalls of 14 percent, 19 percent, and 40 percent would cause increases in soil loss of 15 percent, 18 percent, and 40 percent, respectively. Consequently, soil fertility and land productivity, particularly in upland regions, would decline by 4 to 18 percent in Citarum, 9 to 17 percent in Brantas, and 10 to 27 percent in Sadang (State Ministry for the Environment, 1994)

Aside from the loss of arable land due to sea level rise, the anticipated nationwide effect of soil degradation alone is that yields of upland crops such as soy bean and maize will decline by 20 to 40 percent (whereas rice yields would decline by only 2.5 percent as rice is planted primarily in lowland regions). Impacts are likely to be most serious in upland areas where farmers will suffer from deteriorating soil quality and

abrupt changes in water supplies due to soil erosion and new precipitation patterns (ibid).

Drought events in 1994 and 1997 were considered the worst during the 20th century. Those droughts affected 161,144 ha to 147,126 ha of paddy fields in Indonesia, leading to a significant decrease of national rice production. Social vulnerability as a result of the drought events will be more severe if the recurrence of ENSO event is predicted to be more frequent, that is once in 2 to 3 years (Ministry of Agriculture, 2003)

Naturally, productivity will decrease in the dry season as a consequence of decreased rainfall and soil humidity. This will affect crop fields that rely solely on rainfall or natural irrigation. Global change in climate is believed to be one of the factors contributing to increased frequency and intensity of droughts. The table below illustrates the decrease in productivity as a result of prolonged droughts in 1990s and 2000s.

Table 12. Impacts of droughts on agriculture productivity (Sutardi 2006)

Year	Decrease in Productivity (Ha)	Harvest Failure (Ha)
1990s		
1994	489,178	150,319
1995	18,462	3,385
1996	48,490	11,458
Total	**556,130**	**165,162**
2000s		
2001	145,545	11,344
2002	298,678	30,694
2003	430,258	82,690
Total	**874,481**	**124,728**

The occurrence of El Nino in 1997 is instructive as an example of how hotter climate and disrupted hydrological cycle can affect the agriculture sector in Indonesia. The 1997 – 1998 El Nino event was the worst reported in 50 years, making 1998 the hottest year in the century. In that period, Southern Sumatra and Kalimantan, on the island of Borneo, Java and eastern parts of the country have suffered unseasonably dry conditions for several months. The first monsoon rains that normally begin in September came much later in November. Official estimates currently indicate that drought could affect some 426,000 hectares of rice. Important income-generating non-food crops such as coffee, cocoa and rubber were affected as well (Reilly, 1996)

Impacts on Human Health

Climate change poses higher risks to human health for the following reasons. First, changes in the hydrological cycle will increase the risks of expansion of water-borne diseases such as diarrhea, and the expansion of vector-borne diseases such as malaria and dengue due to the expansion of the water-based habitats of the vectors. Second, a warmer world will expand the vector-habitable areas. For example, malaria- and dengue- transmitting mosquitoes will be able to live in higher altitudes as well having more watery areas for breeding. Third, the incubation periods of the vector-transmittable diseases are shorter, or may instigate mutation of the viruses.

Direct impacts of climate change on human health can manifest in the form of: climatic stress, heat disorders, alteration of immune response, and cataracts. Furthermore, the indirect impacts comprise of: increase in mosquito-borne and snail-borne diseases as a result of changes in agricultural practices; increase in overcrowding and under nutrition leading to higher frequency of tuberculosis, measles and plague; increase in vector-borne diseases caused by overwhelmed sanitation systems; and higher incidence of water-borne diseases as a result of increased frequency and magnitude of flooding and droughts (State Ministry for the Environment, 1994).

The same report predicted a significant rise in malaria, dengue fever and diarrhea cases within the next 81 years using 1989 as the baseline year. There will be an increase of 541 cases of malaria per 10,000 people from 2,705 cases in 1989 to 3,246 cases per 10,000 people in 2070. Dengue fever cases will rise to 26 cases per 10,000 people in 2070 from only 6 cases per 10,000 people in 1989. And diarrhea cases will triple to 924 cases in 2070 from 311 cases per 10,000 people in 1989 (State Ministry for the Environment, 1994)

The 1997 – 1998 El Nino event can once again be a good proxy of the impacts of a warming world on public health. In 1997, Malaria had spread to high elevations, and for the first time it was detected as high as 2,103 m in the highlands of Irian Jaya (Epstein, et al., 1998). In 2004, it appeared that more virulent strain of the potentially deadly dengue virus may have emerged. Dengue fever has been spreading faster and killing more victims than in past years. There has been speculation as to whether the high number of patients and death toll in 2004 was caused by a new strain of the virus.[14] Mosquito breeding is another factor responsible for the higher number of dengue cases. This factor depends on temperature and rainfall. Changes

[14] Nevertheless, WHO claimed that new strain of virus was unlikely.

in temperature and rainfall may stimulate mosquito to expand its habitat (International Herald Tribune, 2005)

Perhaps as a forewarning of what is to come, the rise in the number of dengue fever cases during the rainy season in Indonesia, particularly on Java, could have been partially caused by the warmer climates. Previous research confirmed that warmer temperature has led to mutation of the dengue virus, making cases more difficult to handle, thus leading to an increase in fatalities. According to the Health Ministry as quoted by The Jakarta Post, the total number of sufferers in Indonesia as of January 2007, which is 8,019, is lower than 2005's figure of 18,929. But the fatality rate was 1.8 percent higher than that of January 2006, which stood at 1 percent. (The Jakarta Post, 2007)

SEA LEVEL RISE, OCEAN WARMING, AND CORAL BLEACHING

Sea level rise are expected to happen due to the combination of melting of glaciers and polar ice caps and thermal expansion of ocean water. Current evidence of climate change includes the widespread retreat of glaciers on five continents (Chanton, 2002). The climate change-induced increase of temperature will accelerate the rate of sea level rise. This could make flooding more severe especially during heavy rainfalls.

The last assessment by Working Group I of IPCC in February 2007 shows that the sea level has risen by an average of 2.5 millimeters (mm) annually and was predicted to rise by 31 mm over the next decade. Indonesia, an archipelagic country with over 17,000 islands and 80,000 kilometers of coastlines is very vulnerable to sea level rise. If (or when) the trend of rising sea level continues, Indonesia may lose as many as 2,000 low-lying islands – including coral reefs and uninhabited islands – by 2030. Additionally, rising sea level of between 8 – 30 centimeters (cm) by 2030 is likely to cause severe impacts. At this magnitude of rise, low-lying coastal cities such as Jakarta and Surabaya will have higher risks of flooding.[15]

[15] A projection of sea level rise in the Jakarta bay to 2050 exists and a series of results from such modeling exercise was presented to the authors of this paper. Parts of the results have also been quoted in national newspapers. However, the owner of the modeling results – associated with a public university in Indonesia – decided to withdraw his permission to make use of the results, hence the exclusion of those projections from this paper.

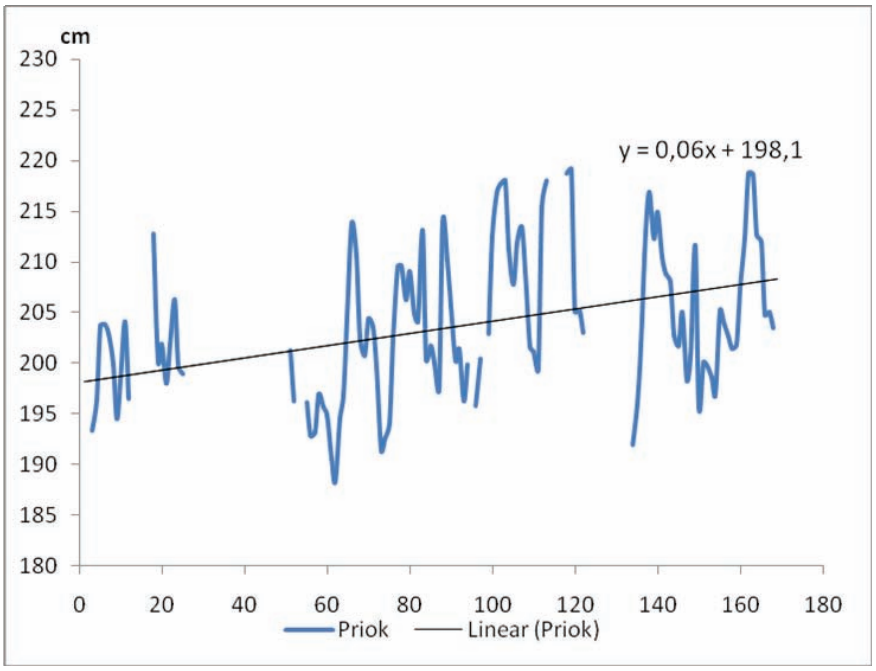

Figure 26. Trend of Mean Sea Level Rise in Tanjung Priok (Supangat, 2007)

As quoted from the Jakarta Post, the water level in Jakarta Bay would rise by 57 millimeters per year. Some 160 square kilometers of Jakarta, including Cilincing, Koja, Tanjung Priok, Pademangan and Penjaringan, would be underwater by 2050. The presence of buildings higher than six stories in Central Jakarta worsened the situation as it has caused the land to subside by between 22 and 75 cm cm in two years (The Jakarta Post, 2007).

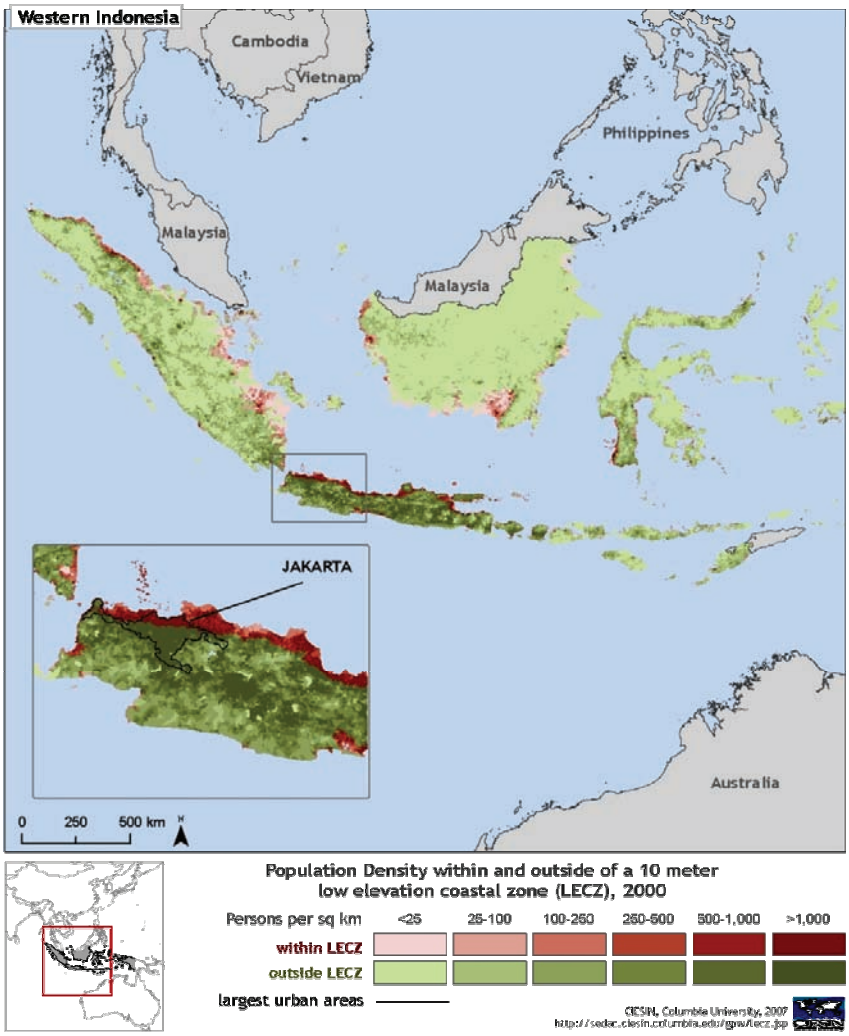

Figure 27. Population Density Within and Outside of a 10 m Low Elevation Coastal Zone (CIESIN, 2007)

Moreover, Columbia University recently published a map that showed the risk of sea level rise to Indonesia (see Figure above). Areas with a density of more than 1,000 people per square kilometres such as Jakarta, Yogyakarta, Semarang, Surabaya, are areas which will get hit the most by sea level rise (CIESIN, 2007). In total, 41,610,000 Indonesians live within ten meters of the average sea level. They are the most vulnerable to sea level changes (IIED, 2007).

Ocean Warming

The future warming of the ocean water in Indonesia will be less rapid than the global average. This is due to the fact that equatorial ocean water surrounding the islands warms slowly. Over land, the warming rates are higher than those of the ocean water, varying from 0.1 ^{o}C per decade for low scenario to 0.3 ^{o}C per decade for high scenario (Hulme, et al., 1999)

The climate change-induced increase in the temperature of the ocean water will pose potential long-term risks to marine ecosystem. The consequences of ocean warming include coral bleaching, shifting of habitats – and disappearing or marine species in its extreme cases. Coral bleaching is the most visible parameter of disruptions to marine ecosystems. It is marked by a condition in which coral reefs turn white due to stressor exposures. The stressors include calcification, pollution, destructive fishing practices, freshwater exposure, and increased temperatures. Bleached corals lose their source of energy if their symbiotic algae are exposed to stressors, leading to coral mortality. A study found that global warming enhances coral reef calcification. In 40 colonies measured in Thailand, Australia, Hawaii, and Indonesia, it was shown that there is 0.3 gram per square centimeter per year increase in calcification per 1^{o}C of warming.[16]

Indonesia has over 50,000 km^2 of coral reefs or about 18 percent of the world's coral reefs. Data from 414 reef monitoring stations throughout Indonesia in 2000 found that only 6 percent of the coral reefs are in excellent condition. About 24 percent are in good condition, while the remaining 70 percent are in either fair or poor conditions (John Hopkins University and Terangi, 2003). Pollution and destructive fishing are believed to be the main cause of coral bleaching in Indonesia, but further warming of the ocean water possibly would worsen the situation and prevent the recovery of the reefs. A massive worldwide bleaching in 1997 – 1998 leading towards widespread coral mortality was triggered by the increase in ocean temperature.

Many more case studies generally show that bleaching impacts differ from one species to another. Many reports state that fast-growing species are more susceptible than slow-growing ones. Fast-growing species recover much more

[16] A participant in one of the Roundtable discussions in the process of preparing this paper insisted that there was no link between climate change, ocean warming, and coral bleaching and insisted on highlighting destructive fishing as the key cause of coral bleaching. While the impacts of destructive fishing on coral bleaching has been acknowledged, scientific evidence shows the link between the risks of coral bleaching and ocean warming, and between the risk of ocean warming and climate change. See, among others, all IPCC reports on scientific basis (Working Group I) on impacts and adaptation (Working Group II), namely the First, Second, Third, and the upcoming Fourth Assessment Reports (1991, 1995, 2001, and upcoming 2007).

slowly than slow-growing species. Some sources mentioned that some reefs may receive coral larvae carried by ocean currents. This may enable young corals to grow under certain circumstances. However, there were also corals that did not recover significantly even after 7 years of bleaching (Marshall and Schuttenberg 2006 in Setiasih, 2006).

There is no implication that El Nino is caused by, or causes, climate change. Nevertheless, the impacts of an event where average temperature is significantly higher than usual can be used as a proxy of how the impacts of climate change could be. Indeed, in the occurrence of climate change, a warmer Earth is a permanent occurrence and therefore the risks are similar with El Nino events. The El Nino Southern Oscillation (ENSO) event in 1997 – 1998 caused coral bleaching to 16 percent of the world's coral reefs. This was in addition to the loss by human impacts that destroyed 11 percent of the coral population (Setiasih, 2006). Bali Barat National Park (BBNP) Coral Monitoring Report (2006), a report for Friends of the Reefs Project of the World Wide Fund for Nature and the Environment (WWF) Indonesia, found that the majority of monitored coral segments of in BBNP were in poor condition as a result of Acanthaster outbreak, storms, and coral bleaching. According to the report, storm and Acanthaster outbreaks occur naturally to promote the coexistence of greater number of taxa. A report by GCRMN found that during the 1997 – 1998 bleaching event, more than 50 percent of the hard coral in BBNP bleached, leading to up to 100 percent mortality. BBNP was then classified as a catastrophically affected site (Wilkinson 2000 in Setiasih et al. 2006).

Impacts on Fisheries

Destruction of coral reefs, loss of fish nursery areas due to mangroves conversion, coastal zone reclamation, destructive fishing methods, pollution of water bodies, and excessive aquaculture such as shrimp farming can all threaten the sustainability of fishery sector. Climate change and climate variability may increase these threats even further even though this remains to be further assessed beyond speculation (Merle, 1998)

The warming of ocean waters interfere with the upwelling of cold, nutrient-rich waters, inhibit the development of plankton, and thus limit the supply of nutrition available to the food-chain. This means fewer fish to catch for human consumption. Furthermore, the temperature anomalies affect the behavior of many fish species, which will tend to seek waters where the temperature is more to their liking and where food is more plentiful. The large congregations of fish within a very limited area may result in massive over-fishing, which is dangerous in the long term (ibid).

The impact of global warming on marine ecosystems is not expected to modify their composition, but only to alter their zone of expansion following the shifting of the isotherms. Global warming generally tends to shift these in latitude, which implies

a progressive expansion of marine habitats from the tropics toward higher latitudes. Nevertheless, if the warming trend accelerates, it is debatable whether the various ecosystems will be able to adapt to such rapid change. The distribution and the abundance of the different marine populations will be more affected by modifications in ocean dynamics (currents) than by the warming itself. It is thus difficult at this time to predict the evolution of marine ecosystems under the influence of the warming of ocean waters except for coral reefs (Merle, 1998)

Climate change will subject Indonesia's marine ecosystems to sea water warming of 0.2 to 2.5^{o}C. Since tropical marine organisms typically live in habitats with temperatures close to the upper limit of their tolerance, even a slight rise in water temperature might have grave effects on their vitality, growth and reproductive rates. Coral reefs destruction will lead to the extinction of marine living organisms including a variety of fishes. These and other changes in marine habitats will have very significant implications for Indonesia's millions of coastal fishermen.

With regards to aquaculture, sea level rise may inundate the brackish water shrimp and fish ponds which are increasingly common on the coast of West, Central and East Java, Aceh and South Sulawesi. Additionally, increased temperatures will cause higher evaporation rates and thus raise salinity levels (State Ministry of Environment, 2003).

Impacts on Biodiversity

Indonesia has a unique crop-related biodiversity. The regions are well-known for their diversity of great crops and other economically important plants such as cereal, tree, spice and fruit species. In addition to ocean warming, other climate change-induced ecological disruptions are expected to affect biodiversity and, likewise, changes to natural ecosystems may also affect the climate. In turn, these can cause losses in biodiversity and other goods and services from the ecosystems (Reid, et al. 2004). Ecosystems that are already harmed by human activities will face more stress resulting from climate change. Species will be more vulnerable and require significant adaptation to new predators and competitors (UNEP, 2007).

There is a possible vicious circle that climate change and forestry – especially peat forest – will create. First, deforestation and especially forest fires will increase emissions of greenhouse gases. Emissions from fires in peat forest are even larger. The emissions will lead to climate change and global warming. A warming world will reduce soil moisture especially in deforested lands. Especially in deforested peat lands, the reduced soil moisture will increase the risks of fires significantly, hence the vicious circle.

Forest fires also destroy large areas that serve as habitat for biodiversity. Plants and animals are eliminated directly by the fires and those survive will diminish gradually. For example, the fires in 1997-1998 caused the population of orangutans to decline by 33 percent on the island of Borneo (Rijksen et al., 2006). Future climate change scenarios indicate that most parts of Indonesia are likely to become warmer and wetter except in the southern parts including Java and Bali which are likely to become drier (Hulma et al., 2006).

5. POLICY GAPS AND CONSTRAINTS

ENVIRONMENTAL POLICY

The key ministry in developing environmental policies in Indonesia, including policies related to climate change, and to serve as focal point for international climate change activities is the Ministry of Environment (LH). The Ministry has several mandates, ranging from coordinating environmental policies, to setting up environmental standards and enforcing environmental laws and regulations. The Ministry, however, does not implement development programs and therefore can only encourage implementing agencies to adopt climate friendly policies in their programs (or "mainstreaming"). Funding for environmental improvement, which includes activities on climate change issues, has increased within the last two years, though it remains modest at the level of 0.5 percent of Indonesia's national budget. Unfortunately, the already modest budget is not entirely managed by the Ministry of Environment but is distributed among several sector based development agencies. The distribution of environmental budget has confirmed the traditional role of the Ministry of Environment as the advocate of sustainable development among members of the cabinet and not the one that has the personnel and budget to implement it.

Indonesia's commitment to address the problems of climate change is codified in Law No. 6/1994 that ratifies the United Nations Framework on Climate Change Conventions (UNFCCC). Furthermore, LH, being the focal point for climate change issues, established the National Commission on Climate Change (NCCC, Komisi Nasional Perubahan Iklim) through Ministerial Decree No 35/MENKLH/1992, and also became the chair of the NCCC. The NCCC serves as an advisory body that provides assistances to the Indonesian government in constructing policies and guidance on how to anticipate the impacts of climate change.

Since its establishment, however, the NCCC has not been able to perform effectively due to institutional and funding constraints (NEDO, 2006). Indeed, the Ministry of Environment faced significant challenges to overcome the problem of contradicting regulations that were issued by development agencies and local governments in its role as the focal point for climate change issues. This legal confusion has hampered

mitigation and adaptation efforts. One such case is the case of mining in protected areas, or another one is forest management versus regional autonomy.

The Ministry of Environment has several policy instruments. The oldest and most famous tool is the Environmental Impact Assessment (EIA or AMDAL), which is a required assessment to obtain permit for development activities with significant impacts to the environment. Until today, AMDAL has no provision for efforts to reduce GHG releases. With on-going attempt to revitalize AMDAL and also with the experimentation of Streamlined AMDAL for Aceh Tsunami Reconstruction projects, there is a window of opportunity to introduce methods and technologies that can be adopted by new development investments to mitigate climate change.

The other important environmental management tool is the Spatial Plan. A good Spatial Plan followed by strong and consistent implementation should be able to reduce the LULUCF contribution to global warming. However, the Spatial Plan Law has placed the responsibility to produce good Spatial Plans on the Provincial and District Governments. The Law does not provide enough enforcement materials for the plans at respective administrative boundaries. The Directorate General of Spatial Planning at the Department of Public Works and the Spatial Plan Team at the National Development Planning Agency (BAPPENAS) are two technical support units that the local governments can ask for assistance.

Technical assistance and financial support from donors on climate change issues are often based on the interests of the donor countries rather than the need of national and local institutions. There is a lack of ownership on climate change projects in several agencies due to the absent of capacity building strategy among the donors interested to support climate change activities.

Furthermore, many countries are more focused on achieving its Kyoto Protocol target; therefore their assistance is aimed at developing CDM projects instead of assisting developing countries to adapt to climate change in their national development policies.

FORESTRY POLICY

The forestry sector is responsible for 85 percent of Indonesia's annual emissions. The main sources of carbon emissions from forestry sector are deforestation which mainly comes from land clearing and forest fires. Indeed, Indonesia is currently facing significant deforestation rate which are mainly caused by land conversion to agriculture and timber estate plantation. Illegal logging activities and forest fire incidents are the main source of deforestation, and these constitute a complex problem.

Reforestation effort is not yet adequate although, according to PP 35/1995, every timber concession holder is responsible for financing reforestation and forest rehabilitation. Rehabilitation to be financed by the reforestation fund includes: reforestation, afforestation, planting management, enrichment planting, application of conservation techniques through planting and civil techniques in degraded land and non-productive areas; while rehabilitation supporting activities includes: forest protection, forest fire management, forest gazettement, management of reforestation fund, seed development, research and development, education and training, extension and community development (State Ministry of Environment 2003).

There are underlying causes of forest degradation, and reducing the rate of deforestation needs to take into account – if not address and find solution to – these issues. The underlying causes go back historically to the political as well as economic motivations to begin forest utilization as a source of growth in Indonesia. The past and current forest conditions in Indonesia have been a direct result of the assortment of external causes such as the El Niño, climate variability, and the longer term problem of climate change. But the problems lie on the underlying causes of long-standing destruction of the Indonesian forests: institutions, governance, and straight economics (Sari, et al., 2002).

Among the most significant underlying causes of deforestation in Indonesia is the uncertainty of land tenure. This uncertainty has led to conflicts in many areas. The conflict takes place not only between the government and the local people, but also among different sectors, between central and local government, and among the people themselves (Panjiwibowo, et al., 2003). Then, another key underlying cause already acknowledged by many is governance and the institutional arrangement of forest management.[17] The problems with tenure and governance limit the options for managing the Indonesian forests sustainably. As a result, degradation continues to occur. Among the largest issues in forest degradation in Indonesia are forest fires and illegal logging. Expansion from the agricultural sector also contributes to forest degradation, but since most agriculture land is owned by smallholders, the conversion rate number is low when compared to the expansion from the plantation such as oil palm, which has been supported by the government and big investors.

[17] Forest Watch Indonesia claimed that deforestation in Indonesia is largely the result of a corrupt political and economic system that regarded natural resources, especially forests, as a source of revenue to be exploited for political ends and personal gain. As part of the effort to boost Indonesia's export revenues and to reward favored companies close to the relative and political allies, at least 16 million ha of natural forest have been approved for conversion to industrial timber plantations or agricultural plantations during Soeharto's era. In many cases, conversion contradicted legal requirements that such plantations be established only on degraded land or on forest land already allocated for conversion (FWI/GFW, 2002).

Regulation PP No. 6/ 2007 has created new hope and opportunity for improved forest management and land tenure. This regulation specifically explains the rules and guidelines for the forest management system in three categories: conservation, protection and production. Each management system has to be based on the principles of good governance, local community development, and improving the investment climate. Yet, the effectiveness of this regulation still needs to be proved, as lessons have been learned about weaknesses of regulations when they are implemented in the field.

Among the largest issues in forest degradation in Indonesia are forest fires and illegal logging. These two issues have received global attention in recent years as both environmental and economic issues. It is considered as a potential threat to sustainable development because of their effect on ecosystems as well as to global warming. For the period 2005-2009, the Ministry of Forestry is focusing on five priority areas: eradication of illegal logging from state forest areas and illegal timber trade; revitalization of the forest sector, especially the forestry industry; rehabilitation and conservation of natural forest resources; people's economic empowerment inside and outside the forest area; and stabilization of the forest area. The Ministry's Strategic Plan for 2005-2009 lays out specific goals for the forestry sector in line with the mission and vision established in the Forestry Law, including increasing support for watershed services, promoting the role of the people, and guaranteeing just and sustainable distribution of benefits (World Bank 2006).

Many laws and legislations on fire and illegal logging have already been established and issued to prevent the forest from degradation. For example, between 2002 and 2006, the Ministry of Forestry has established the "Manggala Agni" Forest Fire Control Brigade in 10 provinces that have potential areas of forest fire, namely North Sumatera, Riau, Riau Islands, Jambi, South Sulawesi, West Kalimantan, Central Kalimantan, South Kalimantan, South Sulawesi and West Sulawesi. Fires Care Community (Masyarakat Peduli Api) has also been established to support the government efforts. Collaboration with the provincial government is also being sought through appealing for Governors in Sumatera and Kalimantan to control illegal logging as the letter issued by Director General Forest Protection and Nature Conservation No. S.762/IV-PKH/2006 dated 13 July 2006, and through the declaration of forest concessionaires issued in May 2006 in Pekanbaru and on 22 Mei 2006 in Pontianak concerning forest fire prevention and mitigation. Regrettably, law enforcement weakness and threat from natural and human disturbance continue to exacerbate the matter.

Similarly, illegal logging is now recognized as one of the most critical problems of forestry and the forest industry in Indonesia; according to some reports, the volume of illegal logging exceeds legal production (International Tropical Timber Organization, 2005). Significant efforts have been taken by the government to tackle the problems of deforestation. Through Presidential Instruction No. 4/ 2005,

Indonesia has codified and reinforces the commitment to fight forest crime. The decree directs eighteen agencies to cooperate in the control of illegal logging and the prosecution of forest crimes. These agencies include the Coordinating Ministry of Political and Security Affairs, the Ministry of Forestry, the National Police, and financial sector regulators. An order of the Ministry of Home Affairs has called for cooperation at the district government level and has prohibited further grants of logging concessions at that level. Officials from Police and Prosecutors Office have been stationed at the Ministry of Forestry, but there is still a need for more detailed plans, budgets, information sharing arrangements and standard protocols (The World Bank 2006).

In general, the forestry policies enacted by the Government of Indonesia related to climate change issue are tabulated as follows:

Table 13. Forestry Policy Matrix

Drivers of Deforestation	Current Specific Policy	Current Cross Issue Policy	Impacts on Climate Change
Land conversion	1. PP No. 35, 1995 on Reforestation fund 2. UU No. 41/1999 and renewed by Act No. 1/2004 on Forestry 3. UU No.22/1999 renewed by the Act No. 32/2004 on Regional Administration 4. UU No 18/2004 on plantations	1. PP No. 6/2007 on forest planning management and forest utilization 2. Permen No.14/2004 on Aforestation and reforestation (A/R) on the CDM scheme 3. PP No. 34/2002 on Land use, forest management planning, forest and forest land use. 4. Permen No.1/2004 on Social Forestry. 5. UU No.23/1997 on Biological Environment Management 6. UU No. 23/1997 on Environment management 7. PP No. 45/2004 on Forest protection	All the policies regulated to achieve sustainable forest management, therefore, at the end it will contribute to the GHG emission reduction through the reforestation effort, protection of forest, and deforestation avoidance.
Forest Fire	PP No. 4/2001 on Controlling environmental damages and or pollution associated with forest and land		
Illegal Logging	Inpres No. 4/ 2005 on Combating illegal logging		

In sum, many good policies are already in place, and substantial support for sustainable forest management is also available. But implementation, enforcement, and continuing problems with governance remain. Some examples of the supports to address the problems of governance are as follows. Forest Law Enforcement and Governance (FLEG) supported by the British government and Forest Law

Enforcement, Governance and Trade (FLEGT) supported by the EU have been established to acknowledge the steps taken by the Government of Indonesia to combat illegal logging. In addition to the United Nations Framework Convention on Climate Change (UNFCCC), other international conventions relevant to forestry sectors such as the United Nations Convention on Biological Diversity (UNCBD) and the United Nations to Combat Desertification (UNCCD) have also been ratified that could allow better and more sustainable forest management.

But despite good policies, the governance problems continue to exist. Conflicts among different sectoral governmental institutions and the emerging conflicts due to decentralization continue to hinder the efforts to find solution to deforestation in Indonesia. The effectiveness of the existing policies depends very much on how they are interpreted further into legal measures and regulations that are implemented on the ground in the provincial and district levels. Indonesian legislation establishes clear goals for the forest sector: economic output, equitable distribution of benefits to improve people's welfare, watershed protection, and conservation. These goals are to build on three interrelated objectives: harnessing the potential of forests to reduce poverty, integrating forests in sustainable economic development, and protecting global forest values. However, Indonesia is not succeeding in meeting these goals, especially in the areas of sustainability and equity (World Bank, 2006).

More ironically, just as forest governance and management policies are showing improvement several energy initiatives currently have the potential to further adversely affect land use and forest cover. The government energy planning documents explicitly state the desire to increase dependence on coal and renewable, while decreasing dependence on oil. Recent Presidential Decree No 5/2006 on "National Energy Management" intends to increase the utilization of coal and to quadruple the use of biofuels in 20 years. The initiative to take advantage of Indonesia's vast coal resources – shifting the fuel mix away from expensive and increasingly imported oil -- has the potential to lead to much more extensive strip mining – affecting already threatened forests in Kalimantan and Sumatra, and at the end, increasing the emission release (World Bank, 2006). Policy on biofuels continue to be controversial and uncertain.

In the era of regional autonomy as it is now, 80 percent of forest revenues belong to the regional government. Law No. 32/2004 clarifies the roles and responsibilities between central, provincial, and district governments. Substantial share of forest revenues are now returned to regional governments according to complex formula based on where the revenues are originated. Although central government retains planning and policy authority for natural resources utilization and conservation, the district governments are responsible for agriculture, environment, and land management.

Returning the forest revenue to the regional government is a good intention. However, improvement of regional government capacity in understanding the importance of good forest management is needed. Uncertainty over the precise scope of responsibility of the regional governments has created vertical conflicts of authorities in the forestry sector. The authority of the regency has full power in managing activities at the regional levels; many people participate in harvesting forest products either illegally or by abusing the permit that prevents forest management from being conducted as regulated (Panjiwibowo, et al., 2003). The conversion of forestland into other usage has precipitated, even though the main purpose of such activity is only to harvest the woods from the area. To date, forest destruction has continued to occur with a rather alarming rate. Regional autonomy and decentralization that have been applied since 2000 apparently has worsened the destruction. Many cases have proven strong involvements of local officials in forest destruction, especially in illegal logging.

The Kyoto Protocol addressed the land use, land use change and forestry issue through the Clean Development Mechanism. PP No. 34/2002 specifically categorizes carbon trading as environmental service concession called the Permit for the Utilization of Environmental Services (Ijin Usaha Pemanfaatan Jasa Lingkungan, IUPJL)". The aspects under this regulation which are relevant to various issues in land use carbon projects include:

- The permit for carbon-based projects' can be carried out in forest area under the category of protection forests as well as production forest, with the duration and areas up to 10 years and 1000 ha respectively.

- Individuals, cooperative, private and state-owned enterprise may apply for the permit, each with maximum 2 permits within one province.

- The permit holder who can satisfy the requirement under the regulation may be granted an extension.

Some articles under this regulation provide further arrangement on authorization in the Central Government, Provinces and Districts, and arrangement of monitoring and evaluation activities mechanism related to sustainable forest management. Basically, this regulation clearly eliminates the chance of doing illegal logging practices and associated trade (State Ministry of Environment 2003).

On 2004, the Ministry of Forestry enacted specific regulation on aforestation and reforestation on the CDM scheme. It contains the guideline for land permit by District Leader, and application of project design document. This regulation also stated the importance of owning the permits which are mentioned in the Government Regulation No. 34/ 2002. Technically, the A/R definition in this regulation is adopting the international standard used in UNFCCC.

Indeed, the necessity to enhance carbon sequestration and avoiding carbon release from the forest sector has been recognized by the government. The Governmental Regulation No. 4/2001, for example, restricts anybody to conduct a burning process in the forest land area. It also explains the collaborative management and responsibilities between the national, provincial, and district government related to the forest fires control and rescue.

ENERGY POLICY

While still being a member of the Organization of Petroleum Exporting Countries (OPEC), Indonesia already experiences bordering between being a net oil exporter and importer at different times. Indonesian oil reserves are already much depleted. Since oil has been the backbone of Indonesian economy and energy resources, the government continues to attempt to diversify the energy sources to enhance energy security. This fact leads to energy diversification policies which are stipulated in Presidential Decree No. 5/2006.

Coal is possibly the most carbon-intensive source of energy, and currently Indonesia still possesses large coal reserves. With current rate of extraction and use, Indonesia may have well over 50 years of coal surplus. Current contribution of coal to the final energy mix is about 14 percent. Through the 2005 National Energy Policy, the Government has set up a target to more than double the contribution of coal to more than 30 percent. This policy will definitely contribute more to the increase GHG emissions from the energy sector.

In summary, the energy policies enacted by the Government of Indonesia related to climate change issue are tabulated as follows:

Table 14. Energy Policy Matrix

Issues	Current Policy	Remark	Impacts on Climate Change
Final Energy Mix	1. Presidential Regulation No. 5/2006 on National Energy Policy 2. KepMen No. 2270 K/31/MEM/2006 on RUKN 2006-20026 3. President Instruction No. 2/2006 on Supply and Liquid Coal Utilization. 4. PP No. 71/2006 on the PLN Assignment as the executor of the Coal Power Plant Acceleration Program 5. PP No. 72/2006 on the establishment of the National Coordinating Team on the Coal Power Plant Acceleration Program 6. PP No. 86/2006 on the Government Guarantee on the Coal Power Plant Acceleration Program	Final energy mix on 2025: Oil ≤ 20 percent, Gas ≥ 30 percent, Coal ≥ 33 percent, biofuel ≥ 5 percent, Geothermal ≥ 5 percent, Renewable Energy ≥ 7 percent:	Diversification energy policy would increase coal shares on the final energy mix. GHGs emission on 2030 would 185 percent higher than those on 2005
Renewable Energy Development	1. Law No. 27/2003 on Geothermal 2. KepMen ESDM No. 1122K/30/MEM/2002 on small distributed power from renewable energy 3. PerMen ESDM No. 002/2006 ttg on medium scale distributed power from renewable energy 4. InPres No. 1/2006 on biofuel supply and development	Target for Geothermal utilization by 2025 is 9500 MW installed capacity. Government will buy (1) small scaled distributed power generated by renewable energy which capacity is ≤ 1 MW; and (2) medium scaled distributed power generated by renewable energy which capacity is 1 ≤ Power ≤ 10 MW with contracting period of 10 years.	
Conservation and Efficiency Energy	1. Kepmen ESDM No. 002/2004 on green energy policy 2. Inpres No.10/2005 on Energy Efficiency 3. Permen No. 5/2005 on Energy Efficiency Implementation		

Directorate General of Electricity and Energy Utilization projects that GHG emissions from coal burning by 2025 will be 20 times higher than the current value at 2005 or 1.3 times higher than total energy sector emission at the same year (Hutapea 2007). The Government of Indonesia, through its national coal policy, recognized that ensuring the growth of the coal industry to be consistent with the

Biofuels in Indonesia: Support or Against Climate War?

Oil reserves in Indonesia are depleting, risking Indonesia to fall deeper into becoming net-importer of oil. Since demand for oil continues to grow, efforts to use biofuel as an alternative have been started. While biofuel itself is renewable, the processes in biofuel production themselves may generate higher GHG emissions than oil when the establishment of the plantations for the feedstocks of biofuels involves clear-cutting existing forests or disturbing the carbon pool in peatswamps.

At present, one of the most viable feedstocks for biodiesel is Crude Palm Oil (CPO). Although the price of CPO is higher than other oil-producing crops, CPO is readily available in abundant because palm oil industry is already established in Indonesia compared to, for example, Jathropa curcas or other feedstocks. Increased demand for CPO for biodiesel will require expansion of oil palm plantations that in turn may put more pressure to the remaining forested areas. In 2009, biofuel from palm oil is projected to reach 2 percent of diesel consumption, or 700,000 kiloliters, requiring more than 200,000 ha of (new) oil palm plantations. Biofuel demand is expected to increase to reach 5 percent of fuels consumed by 2025, equivalent to 4.7 million kl. About 1.41 million ha of palm oil plantation is needed to fulfill the need for CPO. This is an area about 2.5 times the size of the Bali island.

While the regulation firmly states that development of biofuel plantations should only be made on critical and bare lands and should not convert forest areas, many organizations express their great concerns on further forest destruction. Organizations such as Birdlife, WWF and Greenpeace voiced their concern on EU Biomass Action Plan. BirdLife has warned the EU that they must put in place strong environmental safeguards. Without it, reductions in GHG emissions would be negligible and impacts on environment would become severe. In addition, there are major concerns over the potential for rampant destruction of habitats and bio diversity. Kalimantan, the home to large collection of bio diversity, including Orang Utan, is threatened by vast forest destruction. (Yayasan Penyelamat Orang Utan Indonesia, 2007)

concept of sustainable development is necessary. The policy also stresses environment protection as well as safety and health of the industry labor force and its consumers. The energy diversification plan was actualized in the form of the coal acceleration program which was stipulated on several government regulations (see Table 15, above). The government aims to build 10,000 MW coal power plants with total investment of IDR 75 trillion by 2006 - 2009 (Antara 2006).

In contrast with the aggressive target and policy to promote the utilization of coal, the government does not mandate clean coal technology for the state utility company (PLN). The implementation of clean coal technologies, which would improve the thermal efficiency of coal production and use and reduce emissions, could minimize investment risks and give a major boost to the prospects for coal demand. While attention is usually focused on power generation technologies, continuous technological advances are being made along the entire coal chain (IEA 2005).

Several new techniques have been developed for coal mining and the preparation of coal for use in power stations, as well as for coal combustion, emissions control and the disposal of solid waste. Technologies on the horizon such as carbon capture and storage could achieve near-zero emissions of all pollutants from coal-fired power plants. However, cost is the major barrier to the adoption of clean coal technologies. Therefore, government actions, including increased research and development, should help reduce costs. When they do, coal could remain a low-cost source of electricity generation in a carbon-constrained environment (IEA 2005).

Compared to the 1990s, efforts in energy conservation are improving in Indonesia. At the

very least, Indonesia has developed several strong policies on energy conservation. Through Ministerial Decree No. 5/2005, the Minister of Energy and Mineral Resources mandates all government officials to provide simple energy accounting report within six months period to monitor the implementation of energy efficiency. One important contributing factor is the policy to gradually remove subsidies from electricity and fuel prices. Despite the populist reasoning, the fact that energy is no longer cheap helps to change the wasteful energy consumption within the population.

On the other hand, renewable energy development has been very slow if not halted. Although energy policies exist, the supporting instruments such as financial incentives, sales tax on luxury goods, and the like have not been adequately developed. As a result, the renewable energy investment is very limited. The hope for renewable energy was slightly improved as the Kyoto Protocol entered into force. Through the Clean Development Mechanism under the Kyoto Protocol, renewable energy development gained new momentum (see CDM section for more).

Table 15. Renewable Energy Potential Compared to Installed Capacity (DGEEU, 2006)

Renewable Sources	Potential		Installed Capacity	
Hydro	75,67	GW	4,200	MW
Geotermal	27	GW	807	MW
Mini/micro hydro	500	GW	84	MW
Biomass	49,81	GW	445	MW
Solar	4,8	kWh/m^2/day	8	MW
Wind	3-6	m/s	0,6	MW

Developing fiscal policy related to energy, especially those related to renewable energy is very important. The National Resilience Institute (LEMHANAS) identified several instruments that could help improve investment climate in (renewable) energy in Indonesia. They are as follows: tax incentives in the form of value added tax reduction and tax levy, import tax exempt for energy and energy conservation companies. Soft loan measures should also be implemented among renewable energy and energy conservation investment (Kedeputian Bidang Kajian Lemhannas RI 2006).

In comparison, policies on renewable energy and energy conservation in India and China are much more advanced. In renewable energy, for example, India has today among the world's largest program for renewable energy. More than 4,000 MW of power have been produced from renewable resources. The wind energy alone has grown ten-fold within the last decade and ranked fifth in the world. India is one among a few countries in the world that has structural renewable ministries,

augmented by a special financial mechanism, which further encourage political will toward renewable energy development (Renewing India, 2006)

China is the world's largest consumer of coal, accounting for more than 30 percent of global coal consumption. Further, coal continues to provide some 65 percent of China's primary energy demand. While such dependence on coal is not necessarily a curse, it has two mutually reinforcing drawbacks: low energy efficiency and pollution (Andrews-Speed 2005). The environmental impacts of direct coal burning are one of the main sources of air pollution in urban area, especially for Northern China in winter heating period. China is the world's largest SO_2 emitter, thus acid rain pollutes more than 30 percent of Chinese territories and long distance flow of pollutants leads to international concern in East Asia (Research Centre for Sustainable Development, Chinese Academy of Social Sciences, 2006).

Several integrated policies on energy and environment were enacted in China during the period of 1980 and 2000. As a result, energy intensity fell by 64 percent with an average annual conservation rate of 4.6 percent. Besides structural changes, technological advancement played an important role. In short, while the absolute emission kept on growing, the intensity was reduced considerably (ibid)

ADAPTATION POLICY

Indonesia's vulnerability to climate change gives rise to a necessity for the government to take immediate action on adaptation. As elaborated in previous sections, as an archipelagic country, Indonesia is very prone to be affected by rising sea level. Agriculture sector will be adversely affected by climate change. And as a sector that absorbs the majority of Indonesia's employment – even larger when the informal employment is taken into account – the socio-economic impacts may be substantial. As the hydrological cycle is likely to be influenced by global warming, agriculture sector will have to adapt to this change. Moreover, the impact on agriculture is closely linked to food security. Fishery sector is also facing the same problem. Its production and its support to marine ecosystem are threatened by the increase in sea temperature. Increased frequency of droughts, floods and land and forest fires is partially caused by global warming.

Currently the Ministry of Environment is working on the adaptation policy in Indonesia. The Draft of National Strategy on Adaptation which is generated at National Workshop on December 22, 2006 is completed. The draft contains compilation of research activities, identification on adaptation issues which needs to revised and added with implementation experience of UNFCCC methodology. At

present, the Ministry is finalizing the strategy that is expected to be completed by COP13.[18]

Another ongoing work is guidance and tools for local and main stakeholders on vulnerability and adaptation (V and A) assessment which is now in the finalization stage and is expected to be distributed in May 2007. The guidance seeks to adapt the UNFCCC vulnerability and adaptation assessment methodology into Indonesian environment so that it can be applicable for stakeholders in local and national levels. In addition, the Ministry identifies the need to generate specific methodology for vulnerability and adaptation that is tailored to Indonesia's specific environment. The Ministry is in the process of accessing funding to start the study.

The Ministry of Public Works (Department of Infrastructure and Regional Development) has also taken the initiative to develop disaster-risk preparedness and management in response to several disasters in Indonesia which comes in different sizes, such as floods, droughts, and mudslide. The department has also recorded the incidences, status and projections on water balance for each major island. They also have prepared a comprehensive sectoral approach on flood mitigation. In terms of drought mitigation, there are short-, mid-, and long-term programs targeted to the public works sector such as irrigation management, capacity building to farmers, infrastructure for water resources provision, water supply in both rural and urban areas, reservoirs management, watershed and water bodies management.[19]

The Department of Agriculture has also acknowledged that regional climate change and agro-ecosystem changes have caused both intense droughts and floods. It has identified coverage, damage, and mitigation of droughts and floods.[20]

CLEAN DEVELOPMENT MECHANISM

Indonesia signed the Kyoto Protocol in 1997 and ratified it in 2004 through Law No. 17/2004. As a Party to the Protocol, Indonesia can participate in the Clean Development Mechanism (CDM) which is one of the Kyoto Protocol mechanisms that allows participation from non-industrialized countries (non-Annex I countries). Kyoto Protocol of the United Nations Framework Conventions on Climate Change (UNFCCC) entered into force on February 16, 2005, committing Annex I countries to

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[18] Statement from Ministry of Environment representative during Roundtable II, March 15, 2007

[19] Data from Department of Public Works representative obtained in Roundtable II, March 15, 2007. The data needs to be further confirmed regarding the implementation of the policies.

[20] Data from the representative of Land and Water Management Directorate General, Department of Agriculture, which was obtained in Roundtable I, March 02, 2007. The data covers about Flood and Drought issue in the agriculture sector which is identified in the adaptation policy. There is yet to be confirmed regarding mitigation policy in the sector.

reducing their collective greenhouse gas emissions by about 5 percent below their 1990 levels on average by 2008 – 2012. In fulfilling these commitments, the industrialized countries can achieve their emission reduction through several mechanisms, including CDM. The CDM allows companies or entities in developing countries to develop projects leading to reduction of emissions of greenhouse gases, verify and certify these emission reductions, and transfer the Certified Emission Reductions (CERs) to other entities or governments in industrialized countries at a price, thus allowing companies in developing country to cash in on their "carbon assets" efficiently and effectively.

To date there have been various research and studies on CDM that serve important roles in the implementation of CDM in Indonesia. KLH and other state agencies are the main governmental coordinator in cooperation with teams of research institutes, non-governmental organizations (NGOs) and other consulting firms. The Asia Least Cost Greenhouse Gas Abatement Strategy (ALGAS), completed in 1997 for Indonesia, aimed at developing a national GHG inventory and evaluating as well as supporting technology options for abatement of greenhouse gas emissions in all major economical sectors including energy, agriculture, forestry and land use. The first National Communication under UNFCCC, published in 1999, is one of the first studies on Indonesia's GHG emissions and abatement costs. Up to now, however, there is no update on National Communication following the submission of the first National Communication. National Strategy Study on CDM in Indonesia was published in 2001 which is further discussed in the box. Up to today, this is considered as the most thorough and comprehensive study on Indonesian strategy on CDM, starting from GHG inventory and cost, institutional setting, project pipeline and strategy recommendation. However the CDM situation, at global, regional and local level, at present has undergone fast and significant changes since 2001 such that the recommendation in the study may not fit current situation any longer.

CDM-ASEAN (ACE-EAEF) conducted during 2003 to 2005, was launched to facilitate exchange of experiences and improve coordination within the ASEAN region. ADB Technical Assistance on CDM Forestry ended in 2005, aimed at promoting carbon sequestration through CDM in Indonesia. CDM Institution Building project supported by GTZ, which was conducted from 2003 to 2005, has paved the way in supporting the substantial institutional development for CDM implementation in Indonesia. Particularly, the project was instrumental in the establishment of the national CDM authority in Indonesia, the *Komisi Nasional Mekanisme Pembangunan Bersih* (*Komnas MPB*, The National Committee on the Clean Development Mechanism) housed in the Ministry of Environment. Additionally, national approval procedures and other outreach programs to different stakeholders were also facilitated by this project. Aside from the above mentioned studies, several sectoral studies were conducted and are still on-going, comprising capacity

building projects, financing sector involvement on CDM, outreach activities, CDM development on gas flaring, waste and other sectoral projects (NEDO 2006).

The activities mentioned above illustrate how CDM development in Indonesia is influenced greatly by cooperation of the stakeholders, starting with the international donor funding, the governmental agencies, research institutes, NGOs, consulting firms and other stakeholders.

According to the National Strategy Study on CDM in Indonesia, theoretical potential of emission reductions are 125 $MtCO_2e$ from energy sectors and 110 MtCO2e from forestry during 2008 – 2012 (State Ministry of Environment, 2001). Based on the result of the study, Komnas MPB estimates about 125 – 300 MtCO2e of potential emission reductions can be achieved through the CDM. Detailed action plan following the strategy study to monitor the progress of CDM development in Indonesia is still needed, however.

From the establishment of the Komnas MPB as the national authority for CDM in 2005, there are 11 projects that have received Letters of Approval while 1 project is still in review (Ministry of Environment 2007). From the 11 projects, 8 of them are already registered by the Executive Board of UNFCCC with total emission reaching more than 13 MtCO2e. The registered projects are dominated by renewable energy and waste utilization projects. Three of them are biomass projects, two are biogas projects, one solar project, and more. According to CDM pipeline, total emission reduction potential from the 8 registered projects and 7 projects under validation is almost 17 million tons (UNEP RISOE, 2007).

The progress in Indonesia's of CDM project development is rather slow compared to other countries like China, India, or even Malaysia. Up to now, India succeeded in having registered 154 projects that potentially generate more than 145 MtCO2e of emissions reduction. This is more than 10 times Indonesia's number. In China, there are 37 registered projects, but account for more than 350 MtCO2e of emission reduction. This is 27 times of Indonesia's emission reduction from current registered projects.[21]

In 2001, National Strategy Study on CDM was developed to for attracting CDM investment and implementing CDM projects in Indonesia. Some of the considerations are technical potential for and cost of GHG emission reduction projects; international market scenarios, including the size of the CDM market and the factors that will affect Indonesia's share; the international and national institutional settings for the CDM; lessons learned from pilot emission reduction projects in Indonesia and a range of potential CDM projects that could be implemented relatively quickly. In order to analyze the impacts that different policy scenarios and implementation rules would have on the CDM in Indonesia, a dedicated computer simulation model has been developed (PET – Pelangi's emissions trading model). The NSS discussed Clean Development Mechanism potential through the GHG emission profile and projections and the marginal abatement costs, Indonesia's position in the global carbon market, project pipeline, and strategy recommendation which include technical, institutional and negotiating strategies and the priority of strategies. (State Ministry of Environment, 2001)

REDUCTION OF EMISSIONS FROM DEFORESTATION

The deforestation debate opened in Montreal when a coalition of 15 rainforest nations led by Papua New Guinea and Costa Rica floated a proposal to allow CDM-type credits for reduced deforestation.[22] The concept of so called "avoided deforestation" is a concept where countries are compensated to prevent deforestation that would otherwise occur. By maintaining intact forest ecosystems, it will also preserve biodiversity and genetic resources, keep the existing carbon locked into terrestrial ecosystems, and provide a major source of sustainable development income to forest dwellers. The funds came from industrialized countries seeking to meet emissions commitments under international agreements like the Kyoto Protocol. Policymakers and environmentalists alike find the idea attractive because it could help fight climate change at a low cost while improving living standards for some of the world's poorest people, safeguarding biodiversity, and preserving other ecosystem services. A number of prominent conservation biologists and development agencies including the World Bank and the U.N. have already endorsed the idea.

The proposal led to a workshop in 2006 where Brazil outlined a competing approach that was then elaborated in the 2006 COP/MOP in Nairobi, Kenya. Under Brazil's approach, countries reducing their deforestation rates would not get credits that could be sold on the emissions trading market, but payments from an international fund supported by donor country contributions. Brazil argues that its approach would result in greater environmental benefit because the resulting emission reductions would be above and beyond – rather than substituting for – those of developed countries.

The debate deepened in Nairobi, with tropical forest countries other than Brazil offering competing views on the types of incentives that should be offered to reduce emissions by slowing deforestation. The issue drew intense interest in part because it was the one area where developing countries have offered concrete proposals to reduce their emissions (Pew Climate 2006).

Negotiations focused narrowly on the agenda of a second workshop to be held prior to the May 2007 meeting of SBSTA. Although the United States wanted to confine the agenda to technical matters, Subsidiary Body for Scientific and Technological Advice (SBSTA) decided the workshop would focus on "ongoing and potential policy approaches and positive incentives" and related methodological issues. SBSTA plans to consider the results of the two workshops in May 2007 and possibly offer recommendations to COP 13 (ibid).

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[21] Calculated from CDM Pipeline 15 February 2007, http://www.uneprisoe.org/

[22] These nations include Bolivia, Central African Republic, Chile, Costa Rica, Democratic Republic of Congo, Dominican Republic, Fiji, Gabon, Guatemala, Nicaragua, Panama, Papua New Guinea, Republic of Congo, the Solomon Islands, and Vanuatu

Indonesian Ministry of Environment just recently stated that Government of Indonesia is lobbying UNFCCC to fight for the incentive of forest conservation and utilization of adaptation fund through regional approach (Koran Tempo 2007). Other agenda is to fight for technology transfer using multilateral fund from ozone fund through sector approach. Latest event on the discourse was workshop on reducing emissions from deforestation in developing countries conducted on March 7th – 9th, 2007 in Cairns, Australia.[23] Indonesia submitted its views at the event.

Indonesia has put a high priority on the issue of REDD as the country is currently facing the challenge of deforestation and forest degradation which could contribute to global CO^2 emissions. Efforts towards sustainable forest management, rehabilitation of degraded forest and non-forest land, and protected area management could also contribute positively in reducing global emissions and restoration of other global environmental functions.

Given the fact that forest resources play an important role in national development of many developing countries, including provision of livelihoods for many local people, Indonesia acknowledges the need for appropriate policy approaches that would not jeopardize its economic development and livelihoods while maintaining the interest of the global community as well as future generations to reduce emissions from deforestation in developing countries. Thus, it requires contribution from international communities, taking into account the following guiding principles : common but differentiated responsibilities, real benefits for the climate and integrity with other international regimes related to forestry, sovereign rights of the country where the forest located, and sustainable development objectives.

Government of Indonesia proposes an alternative definition for deforestation, that is the loss of forest due to human activities which include conversion of forest to other uses that have lower carbon stocks, and loss of forest due to continuous degradation resulting from repeated fires, and illegal logging. As a consequence of adopting this definition, voluntary actions done by developing countries which include (i) enrichment planting in secondary forests, (ii) targeted emissions reduction through avoid conversion of forest to other land uses that have lower carbon stock, (iii) targeted emission reduction through combating illegal logging and fires, and (iv) conserving carbon through forest conservation should be eligible for the compensation. The Government of Indonesia has also proposed an approach for determining the amount of compensation for disturbed and undisturbed forests.

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[23] The workshop is part of a two-year process on deforestation launched at the UN Climate Change Conference in Montreal in December 2005. Source: UNFCCC, Workshop on reducing emissions from deforestation in developing countries 7-9 March 2007 in Cairns, Australia. Available at http://62.225.2.52/methods_and_science/lulucf/items/3896.php

6. CONCLUSION

The trend of Indonesia's greenhouse gas emissions have reached an alarming level. Through the contribution of emissions from land use change and forestry, about 85 percent of the country's annual emissions, Indonesia is placed in the big three most polluting countries in the world. The rest is attributed to the rapidly-growing emissions from the energy sector and to a lesser extent those from the agriculture and waste.

The impacts of climate change on Indonesia, as on other parts of the world, are disastrously adverse. Prolonged droughts, increased frequency of extreme weather events, heavy rainfalls leading to heavy floods, are among a few examples of what climate change may bring to Indonesia. As an archipelago with more than 17,000 islands, Indonesia is very vulnerable to sea level rise. Quite significant parts of the productive coastal areas in the country, including the Jakarta bay, will be at risk of inundation with some millions of people exposed to the risk of relocation. Indonesia's rich biodiversity will also be under threat. In turn, all these impacts may threaten the agriculture, fishery, and forestry sectors, resulting in increased threat to food security and the livelihoods of the population.

These facts call for serious attention. Indonesia's vulnerability to climate change has given rise to a necessity for the government to take immediate action on adaptation. At present, the Ministry of Environment is finalizing the country's adaptation strategy in time for the COP13/MOP3 in Bali in December 2007. Several governmental agencies such as the Department of Public of Infrastructure and Regional Development and the Department of Agriculture have tried to develop disaster-preparedness plan to adapt to future climate events. However, climate change adaptation should cover more than just a disaster-preparedness plan. Indeed, Chapter 32 of the country's Mid-Term National Development Plan mentions that Indonesia shall "improve national capacity in adapting climate change issues into development aspects". It is thus imperative for the government to finalize this strategy and integrate those into all national development policies.

Adaptation alone would not slow down the climate change. Indonesia needs to put strong mitigation efforts in place to control its greenhouse gas emissions, albeit in a concerted collective efforts with the rest of the world. Policies and measures need to be in place to address the alarming trends of emissions, especially from land use change and deforestation. Gaps in policies need to be bridged, and policies that contradict with climate mitigation could be reexamined and redirected.

More than 80 percent of national emissions are from land use change and forestry, where 75 percent of those are from deforestation and forest degradation. Many good policies are already in place, and substantial support for sustainable forest management is also available. Yet, implementation, enforcement, and continuing problems with governance remain. Indeed, strong political commitment has to be made within the government to fight deforestation, including addressing the underlying causes of deforestation and forest degradation.

Some policies in the energy sector, the biofuel development for instance, remain controversial as it may potentially contribute to more intense emissions through deforestation when the plantations for the biofuel feedstocks compromise the integrity of the existing carbon pools in the forest and peatswamp. Similarly, the initiative to take advantage of Indonesia's vast coal resources — shifting the fuel mix away from expensive and increasingly imported oil — has the potential to lead to extensive strip mining — affecting already threatened forests in Kalimantan and Sumatra, and at the end, increasing the emission release. This is in addition to the increase in emissions from burning of the coal itself.

In addition to focusing on controlling emissions from land use change and forestry, addressing the alarming growth of emissions from the energy sector is imperative.

Energy efficiency and conservation and rapid development and deployment of renewable energy sources can help. But while the improvement of the efficiency of energy use is acknowledged, development and deployment of alternatives to fossil fuels remain problematic. At present, biofuels have almost been the only renewable sources of energy that gain support. Meanwhile, the especially rapid deployment of coal power plants — among them through the 10,000 MW "crash program" — will increase the growth rate of emissions from the energy sector significantly.

Clean Development Mechanism (CDM) can help developing countries like Indonesia to reduce its greenhouse gases emissions. However, Indonesia has not yet been able to take advantage of this mechanism. Only 11 projects have received approval from the Designated National CDM Authority (DNA) when this paper is written. Of these, eight have been registered by the Executive Board of CDM with a

potential to produce 13 $MtCO_2e$. This figure is insignificant since Indonesia at least has 235 $MtCO_2e$ of emissions reduction potential that can be developed as CDM projects. In terms of CDM implementation, Indonesia is far below other Asian developing countries such a Malaysia, India and China. It is imperative for Indonesia to take advantage of this mechanism since it will reduce the cost for climate change mitigation.

The concept of "avoided deforestation", that is by maintaining intact forest ecosystems using funds from industrialized countries will likely be of great benefit to Indonesia. This issue received significant attention in part because it was the one area where developing countries have offered concrete proposals to reduce their emissions. This "incentives" to manage forests are still in international discourse. Nevertheless, the Indonesian Ministry of Environment just recently stated that the Government of Indonesia is lobbying through the UNFCCC channel to for the incentive of forest conservation and utilization of adaptation fund through regional approach. This mechanism, combined with others, could address the problems of deforestation in Indonesian.

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